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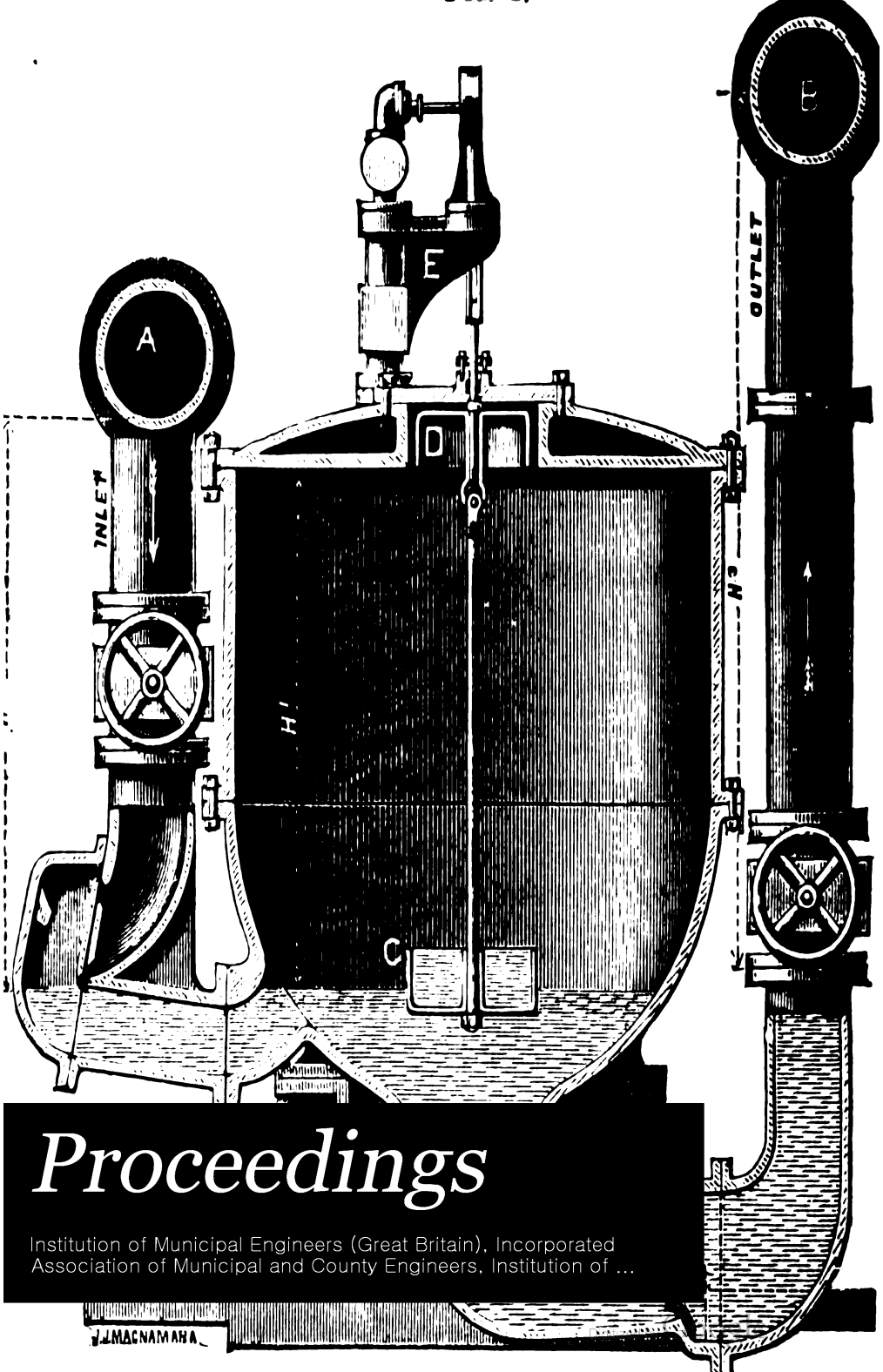

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OF THE

...TUTE OF MECHANICAL ... ENGINEERS AND S...VEYORS.

VOLUME XVI. 1...

EDITED BY

THOMAS COLE,

...S, M. INST. C.E.

Secretary of the Association.

The Association is not as a body responsible for the facts and opinions advanced herein.

E. & F. N. SPON, 125, STRAND, LONDON.

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PROCEEDINGS

OF THE

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

VOLUME XVI.—1889-90.

EDITED BY

THOMAS COLE,

ASSOC. M. INST. C.E.

(*Secretary of the Association*).

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HOLDEN, JAS...	Surveyor to the Highway Board, Llandaff.
HOLT, A., Assoc. M. Inst. C.E.	Borough Surveyor, Lewes, Sussex.
HOLT, G. F.	District Surveyor, Poplar.

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HOOLEY, COSMO C., Assoc. M. Inst. C.E.	Rural Sanitary Authority, Barton-upon-Irwell, Patricroft.
HOOLEY, E. P., Assoc. M. Inst. C.E.	County Surveyor, Nottingham.
HOOPER, J. D.	Surveyor to the Local Board, Woodford, Essex.
HOPE, W. H.	Surveyor to the Rural Sanitary Authority, Kingston-on-Thames.
HOPKINSON, W. H.	Borough Engineer, Keighley.
HORNE, W.	Engineer to the Local Board, Worthing.
HORSFIELD, J. W.	Borough Surveyor, Batley.
HORTON, G. S.	Surveyor to the Rural Sanitary Authority, Market Bosworth.
HOWCROFT, JAMES	Surveyor, Kirkleatham Local Board, Redcar, Yorkshire.
HUGHES, ROBT.	Town Surveyor, Rhyl, Flintshire.
HUMPHRIES, T.	Town Surveyor, Mexborough.
HUTCHINSON, R.	Borough Surveyor, Huntingdon.
INGLIS, J. C., M. Inst. C.E. ..	Surveyor to the Local Board, Compton Gifford, Devon.
IRVING, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
JAMESON, M. W.	Surveyor to the Local Board, South Hornsey.
JEEVES, ED.	Surveyor to the Local Board, Melton Mowbray.
JENKINS, D. M., Assoc. M. Inst. C.E.	Borough Engineer, Neath.
JENNINGS, G.	Borough Surveyor, Rotherham.
JONES, A. S., Lt.-Col., V.C., Assoc. M. Inst. C.E.	Engineer to Urban Sanitary Authority, Wrexham. Wallington Cottage, Carshalton, Surrey.
JONES, C., Assoc. M. Inst. C.E. (*Past President and General Hon. Secretary.*)	Surveyor to the Local Board, Ealing, Middlesex.
JONES, I. M., Assoc. M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
KEMP, J.	Surveyor to the Local Board, Haverhill, Suffolk.
KERRIDGE, JAS.	Surveyor to the Local Board, Walsoken.
KIRK, THOS., Assoc. M. Inst. C.E.	Brisbane, Queensland.
KNOWLES, E.	Late Borough Surveyor, Accrington, Lancashire.
LACEY, F. W., Assoc. M. Inst. C.E.	Town Surveyor, Bournemouth.
LAFFAN, G. B., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgewater.
LAND, GEO.	Surveyor to the Local Board, Norden, near Rochdale.
LATHAM, E. D., Assoc. M. Inst. C.E.	Borough Surveyor, Middlesbrough, Yorkshire.
LAW-GREEN, C., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Nuneaton.
LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Southgate.
LEETE, WM. H.	County Surveyor, Bedford.
LEMON, J., M. Inst. C.E. .. (*Past President.*)	Consulting Engineer, Southampton; and 9, Victoria Street, Westminster.

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LIVESAY, J. G., Assoc. Inst. C.E.	Consulting Engineer to the Local Board, Ventnor.
LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
LOCKWOOD, P. C., M. Inst. C.E.	Late Borough Surveyor, Brighton, Sussex.
LOMAX, C. JAS.	Engineer to the Failsworth Local Board, Lancashire.
LONGDIN, THOS.	Borough Surveyor, Warrington.
LOVEJOY, C. C.	Local Board, Watford, Herts.
LOWE, C. H.	Surveyor to the Vestry, Hampstead.
LUND, J.	Borough Surveyor, Bedford.
MACBRAIR, R. A., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Lincoln.
MACGREGOR, D. M.	Town Surveyor, Berwick-on-Tweed.
MAIR, H., Assoc. M. Inst. C.E.	Surveyor to the Parish of Hammersmith.
MALLINSON, J.	Surveyor to the Local Board, Colne, Lancashire.
MALLINSON, T.	Surveyor to the Local Board, Selby.
MALTBY, F. T., A.M.I.C.E...	Borough Engineer, Dorchester.
MANN, JABEZ	Surveyor to the Local Board, Sevenoaks.
MARKS, H. C., A.M.I.C.E. ..	Borough Engineer, Dewsbury.
MARKS, T. T., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno, Carnarvonshire.
MARSH, R. S.	Surveyor to the Local Board, Cockermouth.
MARSHALL, P. P.	Borough Engineer, Norwich.
MASON, C., Assoc. M. Inst. C.E.	Surveyor to the Vestry, St. Martin's-in-the-Fields.
MASSIE, F., Assoc. M. Inst. C.E.	Surveyor to the Rural Sanitary Authority, Wakefield.
MATHEWS, G. S.	Surveyor to the Local Board, Dorking.
MAWBEY, E. G., Assoc. M. Inst. C.E.	Borough Engineer, Leicester.
MAWSON, JNO...	Local Board, Shaw, near Oldham.
MAY, F. J. C., Assoc. M. Inst. C.E.	Borough Surveyor, Brighton.
MAYNE, C.	Surveyor, Municipal Council, Shanghai.
MAYOR, T.	Surveyor to the Local Board, Gorton, near Manchester.
MCBEATH, A. G., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Sale, Cheshire.
MCCALLUM, J. B., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Blackburn.
MCKELVIE, W., A.M.I.C.E...	City Surveyor, Ely.
MCKIE, H. U., M. Inst. C.E. (*Member of Council.*)	9, Bridge Street, Westminster.
MCLAREN, J.	Surveyor to the Local Board, Amble.
MEABY, M. C.	Surveyor to the Vestry, St. Luke, Middlesex.
MEADE, T. DE COURCY, Assoc. M. Inst. C.E. (*Vice-President.*)	Surveyor to the Local Board, Hornsey.
METCALF, J. W.	Surveyor to the Rural San. Authority, Ashby-de-la-Zouche.
MIDDLEBROOK, S.	Surveyor to the Local Board, Walton-on-the-Hill.
MIDDLEMISS, T. W.	Surveyor to the Local Board, Morpeth.
MIDDLETON, R. H...	Borough Surveyor, Walsall.
MITCHELL, J.	Borough Surveyor, Hyde, Manchester.
MOLINEUX, W. F. T.	Town Surveyor, Shifnal, Salop.
MORGAN, W. B., A.M.I.C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.

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MOUNTAIN, A. H.	Surveyor to the Local Board, Withington, near Manchester.
MURCH, P.	Borough Engineer, Portsmouth.
MYATT, J.	Town Surveyor, Leek.
NEWMAN, F.	Borough Engineer, Ryde, Isle of Wight.
NEWTON, J., M. Inst. C.E. ..	Carlton Buildings, Manchester; Engineer to the Local Board, Bowdon, Cheshire.
NEWTON, W. J., Assoc. M. I.C.E.	Borough Surveyor, Accrington.
NORRINGTON, J. P.	Surveyor to the Vestry, Fulham.
NORRISH, G. R.	Surveyor to St. Saviour, Southwark.
NUTTALL, T., Assoc. M. Inst. C.E.	Surveyor to the Local Boards, Kearsley and Ramsbottom, Lancashire.
PARKER, J., Assoc. M. Inst. C.E.	Surveyor to the Basford Union Rural Sanitary Authority, Nottingham.
PARKER, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.
PARKINSON, JAS., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Turton, near Bolton.
PARRY, A. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Reading.
PATTISON, J., jun.	Borough Surveyor, Newcastle-under-Lyme.
PENTY, W. G.	Surveyor to the Rural Sanitary Authority, York.
PETREE, J.	Borough Surveyor, Jarrow.
PHILLIPS, R.	County Surveyor, Gloucester.
PICKERING, RICHARD	11, Lowther Street, Whitehaven.
PILDITCH, J. T.	Surveyor to the Parish of Battersea.
PLATT, S. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale; *Hon. Secretary*, Lancashire and Cheshire District.
POLLARD, J., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Hendon. 7, Gt. Queen Street, Westminster.
PORTER, R.	Borough Surveyor, Wakefield.
POWELL, D. H. W.	Town Surveyor, Pontypool.
PRICE, JOHN, Assoc. M. Inst. C.E.	Surveyor to the Local Board, Toxteth Park, Liverpool.
PRITCHARD, EDWARD, M. Inst. C.E. (*Past President.*)	37, Waterloo Street, Birmingham; and 2, Storey's Gate, S.W.
PROCTOR, J., M. Inst. C.E. ..	13, Mawdesley Street, Bolton, Lancashire.
PURNELL, E. J.	City Surveyor, Coventry, Warwickshire.
RADFORD, J. C., Assoc. M. Inst. C.E.	District Surveyor, Putney.
RAMSDEN, A.	Surveyor to the Local Board, Chiswick.
RAPLEY, WM., jun.	Surveyor to the Dorking Rural Sanitary Authority.
READ, RICHARD, Assoc. M. Inst. C.E.	City Surveyor, Gloucester.
RICHARDS, HY.	Surveyor to the District Highway Board, Mortlake.
RICHARDS, R. W., Assoc. M. Inst. C.E.	City Surveyor, Sydney, N.S.W.
RICHARDSON, H., A.M.I.C.E.	Surveyor to the Local Board, Oldbury.
RICHARDSON, JAS.	Urban Sanitary Authority, Stamford.
ROBINSON, W. J., Assoc. M. Inst. C.E.	City Surveyor, Londonderry.
ROBSON, O. C., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Local Board, Willesden, Middlesex; *Hon. Secretary*, Home Counties District.

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Ross, P., A.M.I.C.E.	Surveyor to the Local Board, North Bierley, Bradford.
Rothwell, E.	Tramways Co., Rochdale.
Rounthwaite, R. S.	Borough Engineer, Sunderland.
Rowe, Wm.	Tiverton, Devon.
Royle, H., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Stretford, Lancashire.
Ruck, F. W.	County Surveyor, Kent. Maidstone.
Sadler, G. W.	Late Surveyor to the Sanitary Authority, Cheltenham.
Saise, A. J.	Surveyor to the Local Board, Stapleton.
Sasse, G. H.	Surveyor, Clacton-on-Sea.
Savage, Wm. Hy.	Surveyor to the Local Board, East Ham.
Scoones, W. G.	Borough Surveyor, Maidstone.
Scott, H. H., Assoc. M. Inst. C.E.	Engineer to the Commissioners, Hove.
Scott, R. S.	Surveyor to the Local Board, Bishop's Stortford.
Sharman, E.	Surveyor to the Local Board, Wellingborough, Northamptonshire.
Shaw, J. H.	Surveyor to the Local Board, Brownhills, Staffordshire.
Shuttleworth, F. H., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Littleborough, Lancashire.
Siddons, J. M.	Town Surveyor, Oundle.
Silcock, E. J., A. M. Inst. C.E.	Borough Surveyor, King's Lynn.
Sills, S.	Surveyor to the Local Board, Skegness.
Simpson, J.	Quadrant Chambers, Buxton.
Smith, G. F.	Surveyor to the Local Board, Milverton, Warwickshire.
Smith, J. W. M. .. .. .. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District.
Smith, W. H.	City Engineer, Carlisle.
Smythe, F.	Local Board, Finchley, N.
Southam, A., A.M.I.C.E. ..	Surveyor, Clapham, London, S.W.
Spencer, J. P., A. M. Inst. C.E.	48, Collingwood Street, Newcastle-on-Tyne.
Spinks, W., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Dukinfield. 9, Albert Square, Manchester.
St. George, Percival, M. Inst. C.E.	City Engineer, Montreal, Canada.
Stainthorpe, T. W.	Surveyor to the Eston District Local Board, Yorkshire.
Stallard, S.	Surveyor to the Rural Sanitary Authority, Maidstone.
Stephens, R. J.	Surveyor to the Local Board, Belgrave, Leicester.
Stevens, George	Brook Cottage, Blaina, Mon.
Stevens, L.	Surveyor to the Local Board, Wolborough, Devon.
Stewart, A.	Surveyor to the Rural Sanitary Authority, Maldon, Essex.
Stewart, Wm.	Surveyor to the Local Board, Rugby.
Stokoe, J.	Surveyor to the Local Board, Altrincham.
Strachan, G. R., Assoc. M. Inst. C.E.	Late Surveyor, Chelsea. Clovelly, Byne Road, Balham, S.W.
Strachan, J. H.	Surveyor to the Local Board, Brentford.
Stringfellow, H. W.	City Surveyor, Chichester.
Stuart, J. C.	Surveyor to the Local Board, Smethwick.
Stubbs, Wm., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.

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SWARBRICK, JOSEPH, Assoc. M. Inst. C.E.	44, Brasenose Street, Albert Square, Manchester.
SWINDLEHURST, J. E., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Rawtenstall.
SYKES, ED., A.M.I.C.E. ..	Surveyor to the Local Board, Cheadle, Manchester.
TANNER, W.	County Surveyor, Monmouthshire. Newport.
THOMAS, JOHN	Surveyor to the Rural Sanitary Authority, Swansea.
THOMAS, T. J., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Ebbw Vale.
THOMAS, W.	Surveyor to the Margam Local Board, Porttalbot, S. Wales.
THOMAS, W., Assoc. M. Inst. C.E.	Borough Surveyor, Dover.
THOMAS, W. E. C., Assoc. M. Inst. C.E.	Surveyor to the Rural Sanitary Authority, Neath.
THOMPSON, R.	Surveyor to the Local Board, Waterloo, near Liverpool.
THORBURN, T. C.	Borough Surveyor, Birkenhead.
THORBOLD, S. E.	Surveyor to the Local Board, Redditch.
TILL, W. S., M. Inst. C.E.. (*Past President.*)	Borough Engineer, Birmingham.
TOMES, C.	Borough Surveyor, Eastbourne.
TOWLSON, S.	Surveyor to the Local Board, Erith.
TRAPP, S. C.	88, Mosley Street, Manchester.
TURNER, L.	Surveyor to the Rural Sanitary Authority, Headington, Oxford. 18, James Street, Oxford.
VALLANCE, R. F.	Town Surveyor, Mansfield.
VALON, W. A. McINTOSH, Assoc. M.I.C.E.	Ramsgate Corporation Gas Works Engineer. Connaught Mansions, Victoria Street, S.W.
VEEVERS, H., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Dukinfield.
VENTRIS, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. 5, Tavistock Street, Covent Garden.
WAKELAM, H. T., A.M.I.C.E.	Surveyor to the Local Board, Garston.
WALKER, C. L., Assoc.M. Inst. C.E.	Late Surveyor to the Local Board, Wood Green.
WALKER, T., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Croydon, Surrey.
WALLACE, G.	Surveyor to St. Giles District Board of Works.
WALLIS, T. W.	Borough Surveyor, Louth.
WALSHAW, J. W.	Borough Surveyor, Peterborough.
WARDLE, J. W., Assoc. M. Inst. C.E.	Borough Surveyor, Longton.
WATERHOUSE, D.	Surveyor to the Local Board, Watford.
WATSON, J. D., Assoc. M. Inst. C.E.	Burgh Surveyor, Arbroath, N.B.
WATTS, E. T.	Surveyor to the Rural Sanitary Authority, Bishop's Stortford.
WAYE, H.	Surveyor to the Local Board, Millom, Cumberland.
WEAVER, WM., Assoc. M. Inst. C.E.	Surveyor to the Vestry, Kensington.
WEBSTER, J. L.	Surveyor to the Local Board, Portland.
WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
WESTON, GEO.	Surveyor to the Vestry, Paddington.
WESTON, H. J., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Shirley and Freemantle, Southampton.

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WHEELER, G. R. W., Assoc. M. Inst. C.E.	Surveyor to the Vestry, Westminster.
WHEELER, W. H., M. Inst. C.E.	Borough Surveyor, Boston, Lincolnshire.
WHITE, A. E., Assoc. M. Inst. C.E.	Borough Engineer, Hull.
WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
WIKE, C. F., Assoc. M.I.C.E.	Borough Engineer, Sheffield.
WILD, G. H.	Surveyor to Local Board, Wuerdle and Wardle, Lancashire.
WILKINSON, J. P., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Newton Heath, near Manchester.
WILLCOX, J. E., Assoc. M. Inst. C.E.	118, Colmore Row, Birmingham.
WILLSON, J.	Surveyor to the Local Board, Ashford, Kent.
WILSON, GEOFFREY	Surveyor to the Local Board, Alnwick.
WILSON, J. B...	Court House, Cockermouth.
WILSON, J.	Borough Surveyor, Bacup, Lancashire.
WILSON, WILLIAM	Surveyor to the District Local Board, Dalton-in-Furness.
WINDOW, E.R., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Bishop's Stortford. St. George's Chambers, 4, Cable Street, Liverpool.
WINSHIP, G., A. M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
WITTS, J. W.	Town Surveyor, Skelton in Cleveland.
WOLSTENHOLME, J., Assoc. M. Inst. C.E.	Borough Surveyor, Blackpool.
WOOD, A. R.	Surveyor to the Local Board, Tunstall.
WOOD, H. C.	Surveyor to the Parish of Tooting. 1, Great James Street, Bedford Row.
WOODBRIDGE, C. A.	Surveyor to the Local Board, Pinner.
WORSWICK, R. A.	Late Surveyor to the Local Board, Saltburn-by-the-Sea.
WORTH, J. E., Assoc. M. Inst. C.E.	Engineer to the Local Board, Tottenham.
WRIGHT, J.	Late Borough Surveyor, Macclesfield, Cheshire.
WYATT, W. J.	Surveyor to the Local Board, Paignton, Devon.

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GRADUATES.

Ball, Geo.	Borough Surveyor's Office, Scarborough.
Barnes, S. W. J.	Local Board Offices, Ealing, W.
Bayley, G. H.	Borough Engineer's Office, Leicester.
Blizard, J. H., A.M.I.C.E. ..	Lansdowne House, Southampton.
Bradley, J. W.	Borough Surveyor's Office, Burnley.
Bryans, J. G.	Resident Engineer's Office, Calle Piedad, 228, Buenos Aires.
Bryning, W. G.	Borough Surveyor's Office, Wallsall.
Catchpole, J. H.	19, John Street, Hendon.
Crow, A.	35, Queen Victoria Street, E.C.
Fenton, W. C.	Borough Surveyor's Office, Sheffield.
Franks, T. W.	Town Hall, West Bromwich.
Gaffney, F. S., A.M.I.C.E.	35, Dawson Street, Dublin.
Gibbs, L.	Surveyor's Office, S.W.D., Hong Kong.
Glass, S. N.	Town Hall, Fulham, S.W.
Greatorex, A. D.	Surveyor's Office, Town Hall, Manchester.
Houghton, J.	King's Heath, Birmingham.
Lynam, G. T.	Borough Surveyor's Office, Burnley.
Mellor, T. E. W...	Town Surveyor's Office, Tunbridge Wells.
Nickols, F. J.	City Surveyor's Office, Carlisle.
Parker, W.	Borough Surveyor's Office, Hereford.
Pickering, J. S.	East Warwickshire Waterworks, Nuneaton.
Pritchard, T.	Town Surveyor's Office, Richmond, Surrey.
Rich, E. W.	Alderwich House, Hounslow.
Saunders, J.	Borough Surveyor's Office, Newark.
Smith-Saville, R. W... ..	Borough Surveyor's Office, Accrington.
Ward, F. D.	3, Cobden Street, Welshpool.
Young, W.	Town Hall, Salford.

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TOWNS AND DISTRICTS REPRESENTED BY MEMBERS OF THE ASSOCIATION.

ABERGAVENNY	Jon. Haigh.
ABINGDON	G. Winship.
ABRAM	Geo. Heaton.
ACCRINGTON	W. J. Newton.
„	E. Knowles.
ACTON	D. J. Ebbetts.
ALFRETON	V. Hill.
ALNWICK	G. Wilson.
ALTON	J. Barlow.
ALTRINCHAM	J. Stokoe.
ALVERSTOKE	W. H. Fry.
AMBLE	J. McLaren.
ARBROATH	J. D. Watson.
ARMAGH (County)	R. H. Dorman.
ASHBY-DE-LA-ZOUCHE (R.S.A.)	J. W. Metcalf.
ASHFORD	J. Willson.
ASHTON-UNDER-LYNE	J. T. Earnshaw.
ASPULL	Geo. Heaton.
ASTON MANOR	W. A. Davies.
ATHERSTONE (Rural)	W. R. H. Chipperfield.
AUDENSHAW	J. H. Burton.
AYLESBURY	G. Cannon.
BACUP	J. Wilson.
BARKING	C. J. Dawson.
BARTON-UPON-IRWELL (Rural)	C. C. Hooley.
BASFORD UNION (R.S.A.)	J. Parker.
BATLEY	J. W. Horsfield.
BATTERSEA	J. T. Pilditch.
BECKENHAM	G. B. Carlton.
BEDFORD	J. Lund.
„ (County)	W. H. Leete.
BELGRAVE	R. J. Stephens.
BENWELL	T. Dawson.
BERWICK-ON-TWEED	D. M. MacGregor.
BETHNAL GREEN	F. W. Barratt.
BINGLEY	R. Armistead.
BIRKENHEAD	T. C. Thorburn.
BIRMINGHAM	W. S. Till.
„	E. Pritchard.
BISHOP'S STORTFORD	R. S. Scott.
„ „ (R.S.A.)	E. T. Watts.
BLACKBURN	J. B. McCallum.
BLACKPOOL	J. Wolstenholme.
BLAINA	G. Stevens.
BLAYDON-ON-TYNE	M. Hawdon.
BOLTON	W. H. Brockbank.
„	J. Proctor.

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Boston	W. H. Wheeler.
Bournemouth	F. W. Lacey.
Bowdon	J. Newton.
Bradford	J. H. Cox.
Bray, Ireland	F. C. Comber
Brecknock	R. Davies.
Brentford	J. H. Strachan.
Bridgewater	G. B. Laffan.
Bridlington	R. R. Brown.
„	S. Dyer.
Brierley Hill	J. W. Beckley.
Brighton	F. J. C. May.
„	P. C. Lockwood.
Brisbane, Queensland	T. Kirk.
Bristol	F. Ashmead.
Bromley	H. S. Cregeen.
Brownhills	J. H. Shaw.
Burnley	F. S. Button.
Burton-upon-Trent	E. Clavey.
Bury	J. Cartwright.
Buxton	J. Hague.
Canterbury	F. Baker.
Cardiff (Rural)	W. Fraser.
Carlisle	W. H. Smith.
Carshalton	T. L. Heward.
Cheadle	E. Sykes.
Chelmsford (R.S.A.)	A. F. Ginn.
Cheltenham	Jos. Hall.
„	G. W. Sadler.
Cheshunt	T. Bennett.
Chester	I. M. Jones.
Chesterton	D. Bland.
Chichester	H. W. Stringfellow.
Chiswick	A. Ramsden.
Clacton-on-Sea	G. H. Sasse.
Clapham, S.W.	A. Southam.
Cockermouth	R. S. Marsh.
„	J. B. Wilson.
Colchester	H. Goodyear.
Colne	J. Mallinson.
Compton Gifford	J. C. Inglis.
Congleton	R. Burslam.
Coseley	J. Bourne.
Coventry	E. J. Purnell.
Crewe	G. Eaton-Shore.
Croydon	T. Walker.
„ (Rural)	R. M. Chart.
Dalton-in-Furness	William Wilson.
Darwen	W. Stubbs.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
„ (Rural)	C. C. Barras.
Dorchester	F. T. Maltby.
Dorking	G. S. Mathews.
„ (R.S.A.)	W. Rapley, jun.
Dover	W. Thomas.
Dublin	C. Harty.

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Dudley	J. Gammage.
Dukinfield	H. Veevers.
Dunoon	Jas. Collie.
Ealing	C. Jones.
Eastbourne	C. Tomes.
East Ham	W. H. Savage.
Ebbw Vale	T. J. Thomas.
Edinburgh	J. Cooper.
Edmonton	G. E. Eachus.
Ely	W. McKelvie.
Epsom	J. R. Harding.
Erith	S. Towlson.
Eston District	T. W. Stainthorpe.
Failsworth	C. J. Lomax.
Fareham	W. Butler.
Fenton	S. A. Godall.
Finchley	F. Smythe.
Fleetwood	M. S. Gaulter.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.
Fulham	J. P. Norrington.
Garston	H. T. Wakelam.
Gateshead-on-Tyne	J. Bower.
Gloucester	R. Read.
„ (County)	R. Phillips.
Gorton	T. Mayor.
Grantham, Lincolnshire	S. G. Gamble.
Great Crosby	W. Hall.
Great Grimsby	J. Buchan.
Great Yarmouth	J. W. Cockrill.
Halifax	E. R. S. Escott.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Hanley	J. Lobley.
Hanwell	E. J. W. Herbert.
Harborne	R. Dixon.
Harrow	E. R. Capon.
Hartlepool	H. C. Crummack.
Harwich	H. Ditcham.
Haverhill	J. Kemp.
Headington (Rural)	L. Turner.
Heckmondwike	T. Gledhill.
Hendon	S. S. Grimley.
Hereford	J. Parker.
Hertford	T. R. Dickenson.
Heston and Isleworth	W. B. Bromley.
Hexham	R. Grieves.
Heywood	J. Diggle.
Hinckley	W. W. Cooper
Hornsea	P. Gaskell.
Hornsey	T. De C. Meade.
Houghton-le-Spring	T. Foster.
Hove	H. H. Scott.
Hull	A. E. White.
Huntingdon	R. Hutchinson.
Hyde	J. Mitchell.

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IPSWICH	E. Buckham.
ISLINGTON, PARISH OF	C. Higgins.
JARROW	J. Petree.
KEARSLEY	T. Nuttall.
KEIGHLEY	W. H. Hopkinson.
KENSINGTON	W. Weaver.
KENT (County)	F. W. Ruck.
KETTERING	W. Fairley.
KIDDERMINSTER	A. Comber.
KING'S LYNN	E. J. Silcock.
KING'S NORTON (Rural)	R. Godfrey.
KINGSTON (Highway Board)	A. J. Henderson.
„ (Rural)	W. H. Hope.
KIRKLEATHAM	J. Howcroft.
LANCASTER	J. Cook.
LEAMINGTON SPA	W. De Normanville.
LEEDS	T. Hewson.
LEEK	J. Myatt.
LEICESTER	E. G. Mawbey.
LEWES	A. Holt.
LEYTON, E.	W. Dawson.
LICHFIELD	C. J. Corrie.
LINCOLN	R. A. MacBrair.
LITTLEBOROUGH	F. H. Shuttleworth.
LIVERPOOL	H. P. Boulnois.
„	G. Biddle.
LLANDAFF	Jas. Holden.
LLANDUDNO	T. T. Marks.
LOFTUS IN CLEVELAND	C. A. Copland.
LONDON (County)	A. R. Binnie.
LONDONDERRY, IRELAND	W. J. Robinson.
LONGTON	J. W. Wardle.
LOUGHBOROUGH	Geo. Hodson.
LOUTH	T. W. Wallis.
LOWESTOFT	G. H. Hamby.
MARKET BOSWORTH	G. S. Horton.
MAIDSTONE	W. G. Scoones.
„ (Rural)	S. Stallard.
MALDON (Rural)	A. Stewart.
MANCHESTER	J. Newton.
„	S. C. Trapp.
MANSFIELD	R. F. Vallance.
MARGAM	W. Thomas.
MARKET HARBORO'	H. G. Coales.
MELTON MOWBRAY	E. Jeeves.
MEXBOROUGH	T. Humphries.
MIDDLESBROUGH	E. D. Latham.
MIDDLETON, LANCASHIRE	W. Welburn.
MILLOM	H. Waye.
MILTON-NEXT-SITTINGBOURNE	A. B. Acworth.
MILVERTON	G. F. Smith.
MIRFIELD	F. H. Hare.
MONMOUTHSHIRE (County)	W. Tanner.
MONTREAL, CANADA	P. St. George.
MORPETH	T. W. Middlemiss.
MORTLAKE	H. Richards.

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NEATH	D. M. Jenkins.
„ (R.S.A.)	W. E. C. Thomas.
NELSON-IN-MARSDEN	J. A. Crowther
„	W. Dent.
NEW BARNET	G. W. Brumell.
NEWCASTLE-ON-TYNE	W. G. Laws.
„	J. P. Spencer.
NEWCASTLE-UNDER-LYME	J. Pattison, jun.
NEW MALDEN	T. L. Heward.
NEWPORT, SALOP	G. B. Hammonds.
NEWTON HEATH	J. P. Wilkinson.
NEWTON-IN-MAKERFIELD	R. Brierley.
NORDEN	Geo. Land.
NORTH BIERLEY	P. Ross.
NORWICH	P. P. Marshall.
NOTTINGHAM	A. Brown.
„ (County)	E. P. Hooley.
NUNEATON	C. Law-Green.
OKEHAMPTON	H. Geen.
OLDBURY	H. Richardson.
ORRELL	G. Heaton.
OUNDLE	J. M. Siddons.
OXFORD	W. H. White.
PADDINGTON	Geo. Weston.
PADIHAM	J. Gregson.
PAIGNTON	W. J. Wyatt.
PEEBLES	R. S. Anderson.
PEMBERTON	Geo. Heaton.
PETERBOROUGH	J. W. Walshaw.
PINNER	C. A. Woodbridge.
PLUMSTEAD	W. G. Forder.
PLYMOUTH	G. D. Bellamy.
POOLE	J. Elford.
PONTYPOOL	D. H. W. Powell.
PORTSMOUTH	P. Murch.
POPLAR	G. F. Holt.
PORTLAND	J. L. Webster.
PRESCOT	W. Goldsworth.
PUTNEY	J. C. Radford.
RAMSBOTTOM	T. Nuttall.
RAMSGATE	W. A. M. Valon.
RAWTENSTALL	J. E. Swindlehurst.
READING	A. W. Parry.
REDDITCH	S. E. Thorrold.
RHYL	Robt. Hughes.
RICHMOND	W. Brooke.
ROCHDALE	S. S. Platt.
ROCHESTER	W. Banks.
ROTHERHAM	G. Jennings.
RUGBY	W. Stewart.
RYDE	F. Newman.
SALE	A. G. McBeath.
SELBY	T. Mallinson.
SEVENOAKS	J. Mann.
SHANGHAI, CHINA	C. Mayne.
SHAW	J. Mawson.
SHEFFIELD	C. F. Wike.
„	R. Davidson.

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Sherborne	T. Farrall.
Shifnal	W. F. T. Molineux.
Shirley and Freemantle	H. J. Weston.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Skegness	S. Sills.
Skelton in Cleveland	J. W. Witts.
Sleaford	Jesse Clare.
Smethwick	J. C. Stuart.
Solihull (R.S.A.)	A. E. Currall.
Somerton	I. T. Hawkins.
Southampton	W. B. G. Bennett.
„	J. Lemon.
Southend-on-Sea	P. Dodd.
Southgate	C. G. Lawson.
South Hornsey	M. W. Jameson.
Southport	W. Crabtree.
South Shields	M. Hall.
Stamford	Jas. Richardson.
Stapleton	A. J. Saise.
Stockport	J. Atkinson.
Stockton	K. P. Campbell.
Stourbridge	W. Fiddian.
Strand	A. Ventris.
Stratford-on-Avon	T. T. Allen.
Streatham	Jas. Barber.
Stretford	H. Royle.
Stroud	M. Aspinall.
St. George, Bristol (R.S.A.)	Wm. Cloutman.
St. George the Martyr, Southwark	A. M. Hiscocks.
St. Giles	G. Wallace.
St. Luke, Middlesex	M. C. Meaby.
St. Mary, Islington	J. P. Barber.
St. Mary, Newington	J. Gledhill.
St. Martin-in-the-Fields	C. Mason.
St. Saviour, Southwark	G. R. Norrish.
St. Thomas, near Exeter	S. Churchward.
Sunderland	R. S. Rounthwaite.
Sutton, Surrey	E. W. Crickmay.
Swansea (Rural)	J. Thomas.
Swinton, Yorkshire	J. C. Haller.
Sydney, N.S.W.	R. W. Richards.
Tamworth (R.S.A.)	H. J. Clarson.
Tewkesbury, Gloucestershire	W. H. Gray.
Tiverton, Devon	Wm. Rowe.
Todmorden	A. Greenwood.
Tooting	Jas. Barber.
„	H. C. Wood.
Toowong (Queensland)	W. E. Irving.
Tottenham	J. E. Worth.
Toxteth Park	J. Price.
Tunstall	A. R. Wood.
Turton	Jas. Parkinson.
Ulverston	Hy. Whitlow.
Ventnor	E. J. Harvey.
„	J. G. Livesay.

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Wakefield	R. Porter.
„ (Rural)	F. Massie.
Walsall	R. H. Middleton.
Walsoken	J. Kerridge.
Walton-on-the-Hill	S. Middlebrook.
Wanstead	J. T. Bressey.
Warrington	T. Longdin.
Waterloo, Liverpool	R. Thompson.
Watford	D. Waterhouse.
„ (Rural)	G. A. Heath.
Wavertree	I. Dixon.
Wellingborough	E. Sharman.
West Bromwich, Staffordshire	J. T. Eayrs.
West Cowes	N. F. Dennis.
West Ham, London	L. Angell.
West Hartlepool	J. W. Brown.
Westminster	G. R. W. Wheeler.
Weston-super-Mare	A. E. Collins.
Weymouth and Melcombe Regis	W. B. Morgan.
Whitehaven	J. S. Brodie.
„	R. Pickering.
Widnes	T. Higginson.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Withington	A. H. Mountain.
Wolborough	L. Stevens.
Wolverhampton	R. E. W. Berrington.
Woodford	J. D. Hooper.
Wood Green	C. J. Gunyon.
„	C. L. Walker.
Worksop	J. Allsopp.
Worthing	W. Horne.
Wrexham	J. W. M. Smith.
„	A. S. Jones.
„ (Rural)	A. C. Baugh.
Wuerdle and Wardle	G. H. Wild.
York	A. Creer.
„ (Rural)	W. G. Penty.

PARLIAMENTARY COMMITTEE.

E. B. Ellice-Clark, *Chairman.*

Lewis Angell (West Ham).	A. Parry (Reading).
Chas. Jones (Ealing).	O. C. Robson (Willesden).
T. De C. Meade (Hornsey).	W. H. White (Oxford).

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RULES OF THE ASSOCIATION.

I.—That the Society be named the "ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS."

II.—That the objects of the Association be—

a. The promotion and interchange among its Members of that species of knowledge and practice which falls within the department of an Engineer or Surveyor engaged in the discharge of the duties imposed by the Public Health, Local Government, and other Sanitary Acts.

b. The promotion of the professional interests of the Members.

c. The general promotion of the objects of Sanitary Science.

III.—That the Association consist of Civil Engineers and Surveyors holding chief permanent appointments under the various Municipal Corporations or Sanitary Authorities within the control of the Local Government Board, or under the Metropolis Local Management Acts. Each Candidate for Membership shall be proposed by at least two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any office. Civil Engineers and Surveyors holding other chief permanent appointments under any Public Authority within the United Kingdom, or in the Colonies or Foreign Countries, shall be eligible for election as Members, subject to the approval of the Council. The Council shall also have power to elect such Honorary Members as they may see fit.

IV.—That the affairs of the Association be governed by a Council, consisting of a President, Three Vice-Presidents, Twelve Members, and an Honorary Secretary, to be elected annually. The Past Presidents and the District Secretaries for the time being shall also be Members of the Council.

V.—That the Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last-named Nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' Nominations must be

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in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' Nominations should not reach fifteen, the Council shall have the power to make up the total number of Nominations to thirty. Such list of thirty Nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Every Member shall be entitled to vote for or erase any of such Nominations, or substitute other names, subject in all cases to the limits of Rule IV., and return the same within seven days from the date of issue. Such ballot papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of Council shall be considered ineligible for election.

VI.—That the Association be formed into District Committees which shall include the whole of the Members. Such Committees shall meet from time to time, in convenient centres, for the discussion of matters of local and general interest connected with the Association. Each District Committee shall appoint a District Secretary, who will keep records of local proceedings, and communicate with the Council. All District Secretaries shall vacate their office at the Annual Meeting, and Members shall then be appointed to act as Local Secretaries until a District Meeting can be arranged, at which Meeting a District Secretary shall be appointed.

VII.—That a General Meeting and Conference of the Association shall be held annually in such towns, in rotation, as may afford convenient centres for assembling the Members.

VIII.—That each Member pay an entrance-fee of One Guinea, and a subscription of One Guinea per annum.

IX.—That no new Rule or alteration of any existing Rule be made unless Notice of Motion for such purpose, and the proposed Resolution thereon, be sent to the Secretary by the 31st March, and such Notice of Motion and Resolution shall be printed in the Agenda for the ensuing Annual Meeting.

X.—That Candidates successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association, shall constitute a class of Graduates, on payment of an annual subscription of One Guinea; and as such shall be entitled to attend the General and District Meetings and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of the Proceedings, but shall not take part in the election of the Council. Graduates shall be transferred to the class of Member when qualified according to Rule III. A Graduate shall not be required to pay an entrance fee either on his becoming a Graduate or on his transfer as a Member.

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ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

SEVENTEENTH ANNUAL MEETING.

LIVERPOOL, *June 26th, 27th, and 28th*, 1890.

GENERAL BUSINESS.

THE Members assembled in the Council Chamber at the Town Hall, Liverpool, where Mr. Alderman Holden, on behalf of the Mayor, warmly welcomed the Association to Liverpool. Mr. H. Percy Boulnois took the chair, and the Minutes of the Annual Meeting held in Portsmouth, in July 1889, were read, confirmed, and signed.

The SECRETARY then read the Council's Annual Report for the past year.

ANNUAL REPORT.

The Council, in presenting their Seventeenth Annual Report, have much pleasure in being able again to congratulate the Members upon the continued success and steadily maintained progress of the Association during the past year.

Since the last Annual Meeting, in Portsmouth, on the 4th, 5th, and 6th July, 1889, there have been held five District Meetings, viz. at Wimbledon, on the 28th September, 1889; at Acton, Ealing, and Hampton, on the 26th April, 1890; at Hereford, on the 17th May; at Haverhill, on the 24th May; and at Burnley, on the 31st May. These meetings were fairly attended; they fully maintain the high position these meetings hold for instructive value and interest, the various Municipal Authorities contributing to their success by the kind and hospitable reception always accorded to the Association.

The Council considered it almost a new departure to hold a

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District Meeting at Haverhill, as there is no record of a meeting being held at so small a place before. But the result certainly justified the action of the Council, as examples of the work of small towns are of great use to many Members of the Association; and therefore this will not escape the attention of the District Secretaries in the future.

During the financial year ending April 30th last, sixty-two new members, consisting of fifty-six Ordinary members and six Graduates, have joined the Association. Five names have been transferred from the class of Graduate to that of Member. Six names have been written off, three members have resigned, and the Council regret to report the deaths of J. Farrar of Bury, E. Fry of South Hornsey, J. Gordon of London, R. Vawser of Manchester, and W. H. Wilds of Hertford.

The number on the roll of the Association, at the close of the year, was 13 Honorary members, 382 Ordinary members, and 24 Graduates, making a total of 419, as against 371 at the end of the previous year.

The audited balance sheet, which accompanies this report, shows a balance in hand, on April 30th last, of 54*l.* 19*s.* 5*d.* This, taken with the statement of assets and liabilities, shows the financial position of the Association to be sound and satisfactory.

Acting upon a suggestion made at the last Annual Meeting, the Council have invested a portion of the available balance standing to the credit of the Association's current account at the bank, and have, after careful inquiry, purchased three hundred pounds Southampton Corporation Three and a half per cent. Stock, such stock being inscribed in the names of Lewis Angell, H. P. Boulnois, and C. Jones, to whom the Council have given powers to act as trustees with regard to this investment.

The Council have had made a full index to the valuable contents of the first fifteen volumes of the Proceedings, which appeared as an appendix to the last volume. This index will no doubt be welcomed as meeting a want that has long been felt, and will greatly add to the value of the Association's Proceedings as works of reference to the Municipal Engineer.

The Council have reprinted this index in pamphlet form for future use, to be issued at a small cost to cover the expense of printing.

Since the last report, two examinations have been carried out,

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the first of which was held on the 4th and 5th of October, 1889. At this examination, ten Candidates presented themselves, of whom six satisfied the examiners, and were granted certificates of competency. The examiners were Messrs. Laws, Fowler, Jones, and Crimp.

The second examination was held on the 18th and 19th April of this year, when six Candidates presented themselves, and of these four satisfied the examiners, and were granted their certificates. The examiners were Messrs. Jones, Lemon, Lobley, and Meade.

Both of these examinations were held in London, the first one at the Offices of the Association, and the second at the Institution of Civil Engineers, the use of which was kindly granted by the Council of that body.

The Committee appointed at the last Annual Meeting to take the necessary steps to register the Association under the Companies Act, after many meetings, finally settled upon the necessary Memorandum and Articles of Association. These the Council adopted, and they were duly submitted to the Board of Trade. Amendments were made by the Board, which in their turn were reconsidered by the Committee, and the application was at last advertised in the *Times* of the 14th instant. Provided that no objection is taken, it is expected that the affirmative answer will be received about the second week in July.

To meet the incidences of the delay which have unavoidably attended these proceedings, it was advised that the Council last elected should remain in office, and be the first Council under the new régime. Hence the usual Ballot has not taken place, the Members of the Association being duly apprised of this by circular.

The Council regret very much being still unable to lay before the members the report of their Sewer Ventilation Committee. The bulk of the investigations undertaken by the Committee is in the hands of Mr. Laws, and he unfortunately, from the effects of over-work, has been obliged to take absolute temporary rest from all business; but the Council understand that Mr. Laws has made some considerable progress in the collation of the numerous papers and pamphlets submitted to him, and that the work will be resumed on his return from abroad.

The Parliamentary Committee report that during the year they have had several Bills under their consideration, dealing with further powers proposed to be conferred upon Local Authorities; but

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most of these Bills have either been withdrawn, or the subjects with which they deal are so little connected with the duties of the Engineer and Surveyor to Local Authorities, that no necessity exists for any comment thereon. The Public Health Act Amendment Bill, promoted by Mr. F. S. Powell and others, is however of considerable importance, and received careful consideration at the hands of the Parliamentary Committee. Many amendments suggested by this committee were adopted by the Select Committee to which the Bill was referred, but on the other hand the Parliamentary Committee are of opinion that many amendments are still desirable in the Bill as reported upon. At an interview with Mr. Powell upon this subject, he regretted he could not consider, during the present Session, the amendments and certain entirely new clauses which had been proposed, but promised to give them his best consideration with a view to their insertion in another Bill which he proposed to introduce during next Session. The Parliamentary Committee therefore propose to draft certain clauses, and forward the same to Mr. Powell at an early date, the proposed new clauses including such important matters as powers to Local Authorities to charge fees for supervision of buildings, now possessed by a few authorities only; protection of Engineers and Surveyors from the recent interpretation of the 193rd section of the Public Health Act; limited liability of Local Authorities for damage to gas and water mains by use of steam-rollers; powers to charge percentage upon owners for making up new streets; and other clauses now forming portions of Local Acts obtained by various authorities. The committee also propose to suggest to Mr. Powell that in future consideration by Select Committee upon Bills dealing with public health and other matters affecting Local Authorities, members of this Association might be likely to afford assistance by tendering evidence.

With regard to the premiums offered to members of the Association for papers read during the twelve months ending at the last Annual Meeting, the Council, upon the report of the Committee, have awarded the first premium of 10*l.* to Mr. E. J. Silcock, Borough Surveyor of King's Lynn, for his paper entitled "Notes on Electric Lighting," read at the last Annual Meeting held at Portsmouth; and the second premium of 5*l.* to Mr. A. E. White, Borough Engineer of Hull, for his paper on "Municipal Works in Hull," read at the District Meeting in that town. The Council trust that

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the grant of premiums thus instituted will have the desired effect of stimulating members to come forward and strive to further enrich the Proceedings of the Association with high class papers of increased value and enhanced usefulness.

The Report was unanimously adopted. It having been moved and seconded, it was agreed that the various District Secretaries continue in office till the next Meeting in their respective districts.

Messrs. Brooke, Eachus, Lowe, and Radford were appointed Scrutineers for the ensuing year.

Messrs. R. Godfrey and S. Gamble were appointed Auditors for the ensuing year.

The PRESIDENT then read his inaugural address.*

CHAS. JONES, *Hon. Sec.*
THOMAS COLE, *Secretary.*

* This address, and the papers read at the meeting, will be found at the end of the volume.

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Dr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING APRIL 30TH, 1890. Cr.

RECEIPTS.	£	s.	d.
To Balance at Bank (May 1st, 1889)	320	11	5
„ Entrance Fees	57	15	0
„ Subscriptions	323	8	0
„ Subscriptions paid in advance	21	0	0
„ Arrears	17	17	0
„ Publishers' sale of Proceedings	24	16	10
„ Examination Fees	49	17	6
„ Sale of Pamphlet Index	0	6	6
„ Balance of Petty Cash due to Secretary	1	14	7
	£817	6	10

EXPENDITURE.	£	s.	d.
By R. Barnes, Report, Southampton Meeting	3	0	0
„ Messrs. Irvine (Printing and posting circulars) 1st account 32 10 8; 2nd account 9 4 6	41	14	9
„ Reporter, Hull Meeting	2	2	0
„ „ Annual „	10	0	0
„ Sprague and Co. (1st account) 5 0 0			
„ „ (2nd account) 3 0 0	8	0	0
„ Automatic Engraving Co.	0	18	0
„ Messrs. Drake and Driver	0	16	6
„ Expenses, Annual Meeting	16	19	0
„ R. Brealey, Furniture	1	12	0
„ Indexing Volumes i.–xv.	25	0	0
„ Examination Expenses	19	8	0
„ Reporter, Wimbledon Meeting	3	0	0
„ Purchase of Southampton Corporation Stock	304	10	0
„ Messrs. Clowes (Vol. xv. and other Printing)	170	18	5
„ Secretary's Salary	100	0	0
„ Rent of Office	22	10	0
„ Petty Cash—Postages	8	15	0
„ „ Stationery and Sundries	22	19	7
„ Bank Charges	0	4	2
„ Balance at Bank (May 1st, 1890)	54	19	5
	£817	6	10

BALANCE SHEET.

STATEMENT OF ASSETS AND LIABILITIES, APRIL 30TH, 1890.

LIABILITIES.	£	s.	d.
To Estimated Liability on Vol. xvi.	20	0	0
„ Sundry Printing	20	0	0
„ Secretary, Balance of Petty Cash	1	14	7
„ Outstanding Accounts	0	0	0
„ Examiners' Expenses, Estimated	18	18	0
„ Balance	505	9	3
	£566	1	10

ASSETS.	£	s.	d.
By Balance at Bank	54	19	5
„ £300 Southampton Corporation 3½ per cent. Stock	304	10	0
„ Subscriptions in Arrear 112 11 0			
„ „ less 50 per cent. bad 56 5 6	56	5	6
„ Proceedings in Stock 240 13 10			
„ „ less 50 per cent. 120 6 11	120	6	11
„ Office Furniture	30	0	0
	£566	1	10

Examined and found correct, ROBT. GODFREY, SIDNEY G. GAMBLE, *Auditors.* *June 7th*, 1890.

LEWIS ANGELL, *Treasurer.* CHAS. JONES, *Hon. Secretary.* THOMAS COLE, *Secretary.*

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DISTRICT MEETING AT WIMBLEDON.

September 28th, 1889.

Held in the Local Board Offices, Wimbledon,

Mr. L. ANGELL, PAST PRESIDENT, *in the Chair.*

Mr. Thompson, the Chairman of the Local Board, very cordially welcomed the Association to Wimbledon.

The Minutes of the last Home Counties District Meeting, which was held at Southampton, were read and confirmed.

Mr. O. C. Robson, A.M.I.C.E., Surveyor to the Local Board, Willesden, was unanimously re-elected Honorary Secretary for the Home Counties District.

Mr. Crimp then read the following paper:—

WIMBLEDON, ITS PROGRESS AND ITS PUBLIC WORKS.

BY W. SANTO CRIMP, ASSOC. M. INST. C.E., F.G.S.

WIMBLEDON is a well-known suburb of London, its name being inseparably connected with the great annual meeting for twenty-nine years held on its unrivalled common by the National Rifle Association. The sanitary engineer may have found something instructive in these meetings, as there the problem of sewage disposal was most satisfactorily solved, so far as the temporary requirements of the "canvas city" were concerned.

The population of the district is about 25,500, and its area is 3220 acres, 640 acres of which form the Wimbledon portion of the common, the remaining 500 acres being in Putney parish.

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The north-western corner of the common adjoins Richmond Park, and these two beautiful open spaces form a magnificent lung, for ever available as a great health-giving function by the vast metropolis.

The district is, roughly, rectangular on plan, a little under three miles in length, and two in breadth. It may be divided into three zones: the plateau on the south-east of the London and South-Western Railway, having a mean elevation of about 50 above O.D.; the slope connecting this area with the common; and the table-land of the common itself, the mean elevation of which is 180 above O.D.

Like many of the London suburbs, Wimbledon has grown at an extraordinarily rapid rate, as the following table will show:—

Year.	Population.
1851	2,693
1861	4,644
1871	9,087
1881	15,949
1889 (March)	25,300

The rateable value during the period from 1851 to the present time, has increased from 80,517*l.* to 181,582*l.*

Situated on the main line of the London and South-Western Railway, and with increased railway accommodation due to the recent extension of the District Railway, Wimbledon enjoys exceptional facilities for business men, and being moreover an extremely healthy town, as evidenced by a death rate of about 12 per 1000, it enjoys a well-deserved popularity as a residential town, and the time is not, perhaps, far distant, when it will enjoy the advantages of a Mayor and Corporation, like some of the large suburban towns in the neighbourhood.

In the mean time, the Local Board has not been idle, but has borrowed large sums of money, and expended them on various useful and important public works.

The total amount of moneys borrowed from 1874 to the present time, is 176,647*l.*, of which sum 52,541*l.* have been repaid, leaving a balance of 124,105*l.* to be paid.

The main items in these loans are for:—

	£
Main drainage works	60,000
Sewage farm	24,400
Pumping stations and machinery, &c., &c.	20,800
Laying out sewage farm	8,000
Street improvement works	18,000
Burial board	17,500

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The balance having been expended in a variety of ways upon the different necessities of the community.

Three main outfall sewers have been constructed for the drainage of the district. The sewage from that serving the low-lying portion requires to be pumped, whilst that from the other two gravitates to the sewage disposal works.

The high-level outfall commences at the small tanks situated on the sewage farm, passes under the railway by means of a syphon in cast-iron pipes, 18 inches in diameter, and is then continued in brickwork, its section being the old form of the egg shape, its size 2 feet 3 inches by 1 foot 6 inches, and its gradient 1 in 686. At the point A on plan the two principal branches join; these, in their turn, being the recipients of the contents of the various subsidiary sewers. A storm overflow is provided at the point shown on the plan. This portion of the system receives the sewage of about 3500 persons.

The mid-level outfall commences at the sewage works, and passes through part of the sewage farm and the cemetery in a westerly direction, and is the receptacle for the sewage of the intermediate zone. It is constructed of brickwork as far as the Cottenham Park Road, its section being oval and its sizes 3 feet by 2 feet as far as the Wimbledon Hill Road, and 2 feet 3 inches by 1 foot 6 inches as far as Cottenham Park Road. Its remaining portion is of 12-inch stoneware pipes, the various branch sewers being of like construction. The gradient of the brick outfall sewer is 1 in 1320, whilst its branches vary from 1 in 300 to 1 in 8. The population served by this outfall is now about 6500.

The low-level outfall also commences at the sewage works, and passes in a southerly direction to the point C on the plan, whence its course is nearly due west. Its original course is shown on the plan, the dotted lines representing portions now no longer in existence. Its sizes and gradients were as follows:—First portion, 3 feet 9 inches by 2 feet 6 inches; length, 6300 feet; gradient, 1 in 2041. Second portion, 2 feet 3 inches by 1 foot 6 inches; length, 3700 feet; gradient, 1 in 2000. Third portion, 18-inch stoneware pipes: length, 4400 feet; gradient, 1 in 2370. Fourth portion, 15-inch stoneware pipes; length, 3550 feet; gradient, 1 in 1860. At its termination a flushing tank, holding 6000 gallons of water, was constructed.

The design of this outfall was not in accordance with modern practice as regards its gradients, and the inverts were carried

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through at the junctions of the smaller with the larger portions, without the rise necessary to prevent retardation of flow by the backing-up action of the constantly augmented volumes in the larger portions below. The outfall was, in short, a horizontal cesspool so far as the smaller portions were concerned. The remedial works designed and carried out by the author will be described later.

The branch sewers discharging into this outfall are nearly all constructed of 12-inch stoneware pipes having good falls. The population served is 15,000.

There were several miles of sewers in existence at the period when these works were commenced, and these were retained for the disposal of surface water. The author has added largely to these works, their extension having become necessary in consequence of the rapid development of the district. The most important work carried out in this connection is the western outfall, which discharges into the Beverley Brook at Coombe Bridge. It is a brick circular sewer, 4 feet in diameter at its commencement, gradually diminishing in size to 18 inches. Concrete tubes were largely used in its construction as regards those parts having diameters of 18, 21, and 24 inches. The cost of these works was about 6000*l.*

All new roads now made up under the 150th section of the Public Health Act are provided with duplicate means of drainage, and the entire scheme now offers a good example of the separate system, the advantages of the axiom, "the rainfall to the river, the sewage to the land," being both fully recognised and acted upon. Large quantities of roof water are still admitted to the sewers, however, with the consequence that in heavy storms they are sometimes surcharged. The author does not consider it desirable to carry drains for rain-water to the backs of houses in close contiguity to the soil drains, as there would be a great risk of unprincipled persons connecting their soil drains with the rain-water drains in the event of a stoppage of the former, and for this reason all down pipes at the backs of the houses are connected with the soil drains.

The low-level outfall soon became a source of trouble so far as its smaller portions were concerned. The normal flow of the sewage was at the rate of 8 feet per minute only; nearly all the solids were deposited, and after being in use for six years, the

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sewer was two-thirds full of solid matters. The smells emitted from the manholes were, it is needless to say, very offensive.

In 1885 the author was requested to report on its condition, and subsequently to suggest a remedy.

It was decided that if a new outfall was found to be necessary, it should be capable of being extended to the north-western limit of the building land of the district, when future requirements rendered it necessary so to do. Two courses presented themselves; either to construct a new outfall from the existing pumping station, at a depth of about 20 feet below the present outfall, or to construct a smaller pumping station at a site situated in the western portion of the district, reconstructing the smaller parts of the original outfall, and improving it elsewhere. The latter scheme was shown to be by far the more economical and quite adequate to the requirement of the case. The necessary plans were prepared by the author, and the works were carried out in 1885–6.

These works, as designed, comprised the improvement of the tortuous portions of the outfall in Hartfield and Graham Roads, by carrying the main sewer in a straight line from Palmerston Road to Graham Road, and by constructing new 12-inch pipe sewers in place of the old brick outfall, which was broken up. The new sewer was carried under the houses in tunnel, no openings being made in any of the gardens, thus avoiding damage to property and claims for compensation. Its size is 3 feet 6 inches by 2 feet 4 inches, thus being large enough to admit of the sewer men passing through. It was constructed of "Candy's" bricks in Portland cement mortar, and the heading was filled in solid with Portland cement concrete.

The new outfall eastwards from the Wimbledon and Croydon Railway, as designed, was 21 inches in diameter, and its gradient was 1 in 1000. At the point E, its size was reduced to 18 inches, and its gradient was 1 in 900; its termination being the new pumping station, at which point the invert level was 42 O.D. That portion of the outfall, 21 inches in diameter, has not, as yet, been constructed, in consequence of the fact that private lands would have to be crossed, which lands will shortly be developed for building purposes, when the work can be carried out without large claims for compensation being made.

Eastwards from the pumping station, the new outfall commences with an invert level of 17·50 O.D.; it is for a length of

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1000 feet circular in section, 3 feet 9 inches in diameter, its gradient being 1 in 900, this portion being a tank sewer for the storage of the sewage when the pumps are not at work. Its western continuation is 15 inches in diameter, with a fall of 1 in 600 to the Durham Road, whence it is 12 inches in diameter, with a fall of 1 in 500, there being a flushing tank at its termination. These portions of the outfall are constructed of concrete tubes, embedded in concrete, the depth at which they are laid varying from 22 to 30 feet.

The pumping station is provided with a pair of single-acting ram-forcing pumps, the ram being 12 inches in diameter, with a stroke of 24 inches, working at a speed of twenty strokes per minute. These pumps are operated by a pair of "Otto," 3½ nominal horse-power gas engines, the machinery being arranged to work interchangeably, if desired. The ascertained consumption of gas is one cubic foot for each 112 gallons raised, the lift being 33 feet. The sewage is lifted into a tank, holding nearly 20,000 gallons, which, when full, discharges its contents by means of a penstock into the 18-inch outfall, which is thus most effectively flushed, at least twice daily.

The old 18-inch outfall was quite freed from deposit for a considerable length on the commencement of the flushing, but much sand and heavy detritus still resisted the action of the water, as its original velocity was lost, and in order to clear this out the author had a strong copper ball, 15 inches in diameter, made; this ball was placed in the sewer—at the manhole next above the commencement of the deposit—and with each flush worked its way forward, thoroughly cleansing the portions passed through, and bringing out quantities of detritus, including also two bricks. A totally unexpected incident occurred in connection with its use; a long length of sewer had been cleared when the ball stopped and remained at the same place for upwards of a week. The line attached broke, and an opening from the top was made, when the sewer was found to be in a state of collapse; the remainder of the outfall was examined at frequent intervals, and there is little doubt but that all the pipes for a distance of 500 yards are crushed, the stoneware of which they are constructed being unable to resist the pressure of the clay stratum in which the sewer is constructed; the depth below the surface of the crushed portion being from 15 to 18 feet. The pipes were jointed with clay, and thus had not the strengthening assistance of a cement joint, but even with

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cement joints, the author would not trust to pipes unsupported with concrete at the depths named. A new sewer has recently been constructed parallel to the old one.

In addition to the new works described, five automatic flushing tanks were also constructed, each provided with one of Rogers Field's annular syphons. The position of these tanks is shown on the plan.

The total cost of these remedial works has been about 12,500*l*. They have exercised a most beneficial influence, not only as regards the main drainage works themselves, but also the sewage, which now arrives at the sewage works in a fresh state compared with its putrid condition before these works were undertaken.

All the sewers, as originally designed, were ventilated by means of the manholes in the ordinary way, the sewer air escaping at the street level. The ventilators were placed at an average distance of 160 yards apart.

But as is usually the case in sewerage systems ventilated in this manner, complaints of the foul smells arising were of frequent occurrence, and the Board have consistently followed the author's advice, and closed the street ventilators, substituting lamp-posts, pipes up houses and trees, and other means of disposing of the stinking air, in consequence of which measures, complaints are now no longer received, unless it be in respect of a manhole not yet dealt with.

Those members of the Association who are also members of the Institute of Civil Engineers, may have read a paper by the author, which was published in volume xcvii. of the Minutes of the Proceedings. In that paper are given the general results of twelve months' observations on some of the Wimbledon sewers, observations which were made with a view to ascertaining the conditions under which downhill movements of sewer air were effected. The author does not propose to refer to those experiments at any length, but merely to record his opinion that the views hitherto prevailing with regard to the movements of sewer air, must be considerably modified. Temperature must give place to wind as the most powerful agent in causing movements of sewer air, and as a consequence, downhill movements, in cold weather especially, are no longer inexplicable. Throughout the entire series of experiments, the author found, beyond all question, that the wind was the only agent causing movements of sewer air that could be recorded by an anemometer, and that the currents were uphill or

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downhill, accordingly as the individual sewer experimented upon was affected by the wind.

One sewer was experimented upon continuously for twelve months, and as the winds from the S.W. and S. quarter always produced downhill currents, the sum total of the downhill movements considerably exceeded that of the uphill, as S.W. winds are the prevailing winds in this country. It is quite conceivable, and indeed highly probable, that the openings on some sewers might be so situated that a S.W. wind might cause up-currents; when once the principle is established, we shall find that the direction of air currents in sewers may be up or down, or both up and down accordingly as the wind affects the various sewer openings subject to its influence.

With regard to sewage disposal, a portion of the sewage is pumped into the settling tanks, whilst the remainder gravitates into them.

The main pumping station is situated at the sewage disposal works. It contains a pair of high-pressure horizontal condensing engines, with cylinders 14 inches in diameter, and a stroke of 3 feet, indicating 16 horse-power when working at their normal rate of speed. These engines operate a pair of single-acting ram-forcing pumps, each pump having two rams 24 inches in diameter, with a stroke of 4 feet 6 inches. The mean lift is 22 feet, and each pump will lift slightly over 100,000 gallons per hour. Two Lancashire boilers, each 20 feet in length and 6 feet in diameter, supply steam for the pumping and other machinery, the boilers being used alternately for periods of a month.

The sewage disposal works comprise the necessary tanks for the chemical treatment of sewage, and 73 acres of land for its further purification.

There are six settling tanks for the reception of the sewage from the middle- and low-level outfalls, each tank having an area of 50 feet by 49 feet, and a depth sufficient to contain 6 feet of sewage, or about 90,000 gallons. These tanks are arranged to work on either the continuous or alternating system as desired, every tank being provided with a floating arm for the purpose of draining off the clarified sewage from the top in the most approved manner. If desired, the sewage can be passed through the whole series, provision having been made in the division walls for this purpose. As originally designed, there were two tanks only, but as they were constructed with flat bottoms, the labour of clearing the

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sludge was very great; the outlets for the clarified sewage were also situated at the bottom in each case, thus allowing the solids to escape.

The two small tanks near the railway which receive the sewage from the high-level outfall are each 30 feet in length by 20 feet in breadth, 8 feet in depth at each end, and 10 feet at the central division, at which point the sewage enters. These tanks are constructed with a false bottom, on which rests 3 feet of burnt ballast, and the sewage is strained upwards through these filters, the solids being left in the space below. A pipe sewer connects these tanks with the large settling tanks, and on opening a valve, the whole of the sewage in the tanks, with the deposited sludge under the false bottom, passes down to the large tanks; this operation being performed about twice weekly. These tanks have given every satisfaction during the ten years they have been in use.

The chemicals used for precipitation are lime and "Spence's" alumino-ferric, or sulphate of alumina in the proportion of 8 grains of the former and 6 of the latter per gallon of sewage. In very hot weather it was found that a slight odour was given off from the land where the treated sewage was applied, but during the past hot summer much benefit has been derived by the addition to the clarified sewage of 2 to 3 grains per gallon of permanganate of potash.

One of "Scott's" lime-mixers is used for the preparation of the milk of lime, the water used being that from the condensers of the engines. This water is the clarified sewage from the tanks, and, on its temperature being raised, it gives off a slight odour, which is neutralised on passing into the mixer. The milk of lime is conveyed into the pump-well, and in passing through the pumps becomes thoroughly well mixed with the sewage, which is then discharged into a small chamber into which the mid-level outfall discharges; here there is much agitation, and mechanical mixers are not required. The solution of alum is then added, the sewage flows to the tanks, and precipitation of the solids follows in the ordinary way.

The normal flow of the sewage is 750,000 gallons per day; the lime used amounts to 7½ cwt., costing 7*s.* 6*d.*; the sulphate of alumina to 5¾ cwt., costing 16*s.*; wages of man, 4*s.*; total, 27*s.* 6*d.* The cost per million gallons would be 35*s.*, the wages of the man being a constant. The sum of 25*l.* may be added to the annual cost for the permanganate of potash used in hot weather.

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A small centrifugal pump has recently been added for pumping part of the clarified effluent into the small high-level tanks, so as to provide an additional volume of water for the comparatively large area commanded by these tanks.

The treatment of the sludge has been fully dealt with in the paper by the author, read before the Institution of Civil Engineers (see 'Minutes of the Proceedings,' vol. lxxxviii.). Briefly, the sludge is swept from the settling tanks into a reservoir, whence it gravitates into the receivers, being then forced into filter presses by air-pressure. There are two of Johnson's presses and one of Manlove, Alliott, & Fryer's, the latter being the newer and preferable machine. The following notes may be of use where the adoption of sludge-pressing machinery is contemplated:—

One machine, with twenty-four circular plates 36 inches in diameter, will be necessary for 12,000 persons, if worked by day only; if square plates are used, one machine will be sufficient for 15,000 persons. The air-pressure employed need not exceed 50 lbs. per square inch, and it should be applied carefully and gradually on recharging each press. Care must be taken to use perfectly fresh lime for mixing with the sludge, and strong grey chalk lime, finely ground, will yield by far the best results; the quantity required will be 1 cwt. for each ton of cake produced, if rapid work is to be accomplished, say the filling and clearing of a press in 50 minutes; cakes 2 inches in thickness are produced in the same period of time as those of 1¼ inches. Flax canvas, costing about 4¾*d.* per yard when 40 inches in width, will be the best filtering material, the cloths being made up locally, care being taken to well wet the canvas before it is cut up into lengths, otherwise it will shrink and tear when first used in the presses; the liquor filtered out will be a saturated solution of lime with other constituents, and may best be disposed of by being mixed with the crude sewage, the solids in which it will assist to precipitate; its ratio to the sewage-flow will be about 1 per cent. The sludge should be pressed whilst in as fresh a condition as possible; the production of sludge cake with about 54 per cent. of moisture will be 2¼ tons per week per 1000 persons, very nearly; its value as a manure, if applied as a top dressing as it comes from the presses, will be, weight for weight, slightly in excess of stable manure. The working expenses at Wimbledon now amount to 2*s.* 4*d.* per ton of cake.

The sewage farm, as originally laid out, consisted of 47 acres

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of land of a stiff clayey nature, having a considerable slope towards the north-east. It was freely under-drained by means of 4-inch glazed socket-pipe drains, laid in contour lines, about 50 feet apart and 6 feet deep, these being crossed at varying angles by larger main drains having a common point of discharge into the river Wandle. The trenches in which the drains were laid were filled in with burnt ballast to within 2 feet of the surface. On the down-hill side of each of the contour drains, a permanent carrier was constructed of half-pipes with purpose made stoneware sides, as shown in Doulton's catalogue. The main carriers from the tanks were of cast-iron pipes, and were, and are, a really good feature. It was intended that the land should act as a filtration area, on the principles enunciated by Dr. Frankland; but the futility of carrying out laboratory experiments on a large scale, but under different conditions, was never more strikingly exemplified than in the case under consideration. The land was entirely unsuitable for such a mode of treatment; it was drained not wisely, but too well. The surface of the land was left very uneven, and in many places no sewage could be distributed, whilst in others there was too much; as a consequence the sewage was badly purified, and the crops were very poor, the average prices realised during the first four years being only 190*l.* per annum, or 4*l.* per acre.

In dry weather the land cracked in all directions, giving the sewage direct access to the drains, and the effluent from them was actually worse than before being applied to the land, being laden with masses of sewage fungus. It was also found that the permanent contour-carriers interfered very much with the ordinary methods of cultivation, and, being laid at a dead level, and not being jointed, the greater part of the sewage escaped at the commencement of each carrier.

Such was the state of affairs when, in 1880, Mr. James Snook, who was then engaged with the author in laying out the Merton sewage farm under Mr. Baldwin Latham, was appointed farm manager. Under his management things soon assumed a better shape; all the carriers, except the iron mains, were removed; the burnt ballast under the drains was in great part removed, and puddled clay was substituted, whilst the surface of the land was carefully levelled, and it is only due to the Local Board to say that they spared no expense to render these works as perfect as possible.

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One blot, however, remained—the sludge pits, which occupied nearly an acre and were a source of much disagreeable effluvia. These were abolished on the erection of the filter presses by the author in 1884.

Notwithstanding the fact that the land was now in a good condition, the rapidly increasing population—which has nearly doubled in ten years—rendered it necessary to further extend its area. Further purchases of various lands were made, adding an area of 26 acres, 17 acres of which consists of excellent alluvium. This land has been levelled, drained, and prepared for sewage treatment by Mr. Snook and the author conjointly, none of the work having been done by contract.

The utmost care was taken in carrying out the work to avoid the evils pointed out with regard to the original farm, and, with few exceptions, the only drains laid are those under the centre of each road. The new portion is comprised in the eight plots situate on the north-east of the point B on the plan.

All the effluent water from the land on the west of Durnsford Road is intercepted at the point A on the plan, and is conveyed in a drain to a point B, where it is reapplied to the surface of one or other of the plots between that point and the permanent contour-carrier farther north. The effluent from the fields between Durnsford Road and the river Wandle is discharged into the contour-carrier at the point C, and is conveyed by means of the carrier to one or more of the plots on its north-eastern side, and is there reapplied as in the former case. Thus the whole of the effluent from the original farm is applied to the surface of the new portion a second time. The result is that the effluent finally discharged into the Wandle is of excellent quality, no sewage fungus having as yet been discovered in the drains of the land recently laid out, nor evidence of sewage contamination in the sluggish branch of the Wandle into which the effluent is discharged.

Three filters of burnt ballast, with an aggregate area of 2½ acres, and with a depth of 3 feet, have been constructed for the purification of the sewage when it is largely diluted with storm-water, but these are rarely used, the land being sufficient for its treatment in case of moderate falls of rain.

The crops grown are Italian rye-grass, mangolds, osiers, and vegetables, the areas devoted to each kind being 54, 10, 6, and 3 acres, respectively. Five to six crops of rye-grass are produced

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yearly, and these are disposed of, as regards the larger portion, in the green state, the principal purchasers being the cow-keepers of the south-west of the metropolis; all not sold is consumed by the Board's horses, either in its green state, or after being made into hay. The average weight of the grass removed from each acre per annum is about 54 tons. The prices obtained vary from 3*d.* to 1*s.* per square rod, on the ground, for each cutting, the grass being mown by an employé of the Board.

The mangolds grown are of excellent quality, the weight produced per acre having last year exceeded 40 tons; these are sold at from 15*s.* to 25*s.* per ton, in accordance with the ruling prices.

The vegetables are sold at fairly remunerative rates.

Much attention has recently been given to the cultivation of willows and osiers. The willows are readily disposed of to market gardeners, who use them for tying vegetables for the market; whilst the osiers are purchased by basket-makers. The prices now being obtained are about 18*l.* per acre.

The total receipts for produce for the year ending 25th March, 1888, amounted to 1420*l.*, or 20*l.* per acre nearly, as against 4*l.* per acre before the farm was placed under the management of Mr. Snook, whilst the inclusive working expenses were 910*l.*, thus leaving a balance of 510*l.* to assist in the repayment of the interest and principal on the moneys borrowed for the purchase of the land and construction of works. During the year ended March 25th, 1889, the balance in favour of the farm was not quite 400*l.*, but this year there is every prospect of a higher balance.

The cost of the works and land to date are as follows:—

	£
Machinery, buildings, works, &c.	20,866
Seventy-three acres of land	24,432
Draining and laying out original land	6,141
Draining and laying out recent purchases ..	2,000
	£53,439

The annual repayment in respect of that sum is 2869*l.*, pumping and maintenance of machinery costs 520*l.* per annum, precipitation of sewage and sludge-pressing 811*l.*, or a grand total of 4200*l.*; from this deduct the profit on farm, about 500*l.*, and the net annual cost is 3700*l.*, equal to a rate of 6*d.* in the pound on the present rateable value, and 2*s.* 11*d.* per head of the population.

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It is satisfactory to find that with a rapidly increasing rateable value these rates are gradually growing less.

With regard to street improvement works, there is nothing of a novel character to be seen at Wimbledon. Roads now made up under the 150th Section of the Public Health Act are kerbed with granite kerb, paved with either limestone tar-paving or bricks, and are channelled when the roads are very flat or very steep. During the author's tenure of office, he has prepared plans, sections, and estimates for making up 51 roads, a large number of which have been completed, whilst others are now in hand.

The following brief schedule gives the details as regards other foot pavements laid in Wimbledon :—

Asphalt 1 inch in thickness on 3 inches of Portland cement concrete	6*s.* per square yard.
Victoria stone	5*s.* 6*d.* „
Granolithic and Petro-silicon, *in situ*	4*s.* „
Buckley bricks, laid upon 4 inches of fine ashes, and bedded on sand, well rammed	3*s.* 9*d.* „
Limestone tar-paving	2*s.* 4*d.* „

The main roads, and other roads with much traffic, are macadamised with Guernsey granite, costing 15*s.* 10*d.* per cubic yard, whilst the roads with light traffic are repaired with local flints, costing 4*s.* 3*d.* per cubic yard.

Other public works and buildings not needing a special description are the isolation fever hospital; a disinfecting station provided with one of Goddard and Massey's gas chambers; a cemetery of 10 acres with two chapels, and a mortuary and post-mortem room with one of Stevens' patent tables for operations; a recreation ground of nine acres; a fire brigade station, with a manual, steamer, and hose reel; and an excellent Free Public Library.

Although much has been done in the past, much remains to be done consequent upon the rapid growth of the parish, and there can be no doubt but that Wimbledon has an important future.

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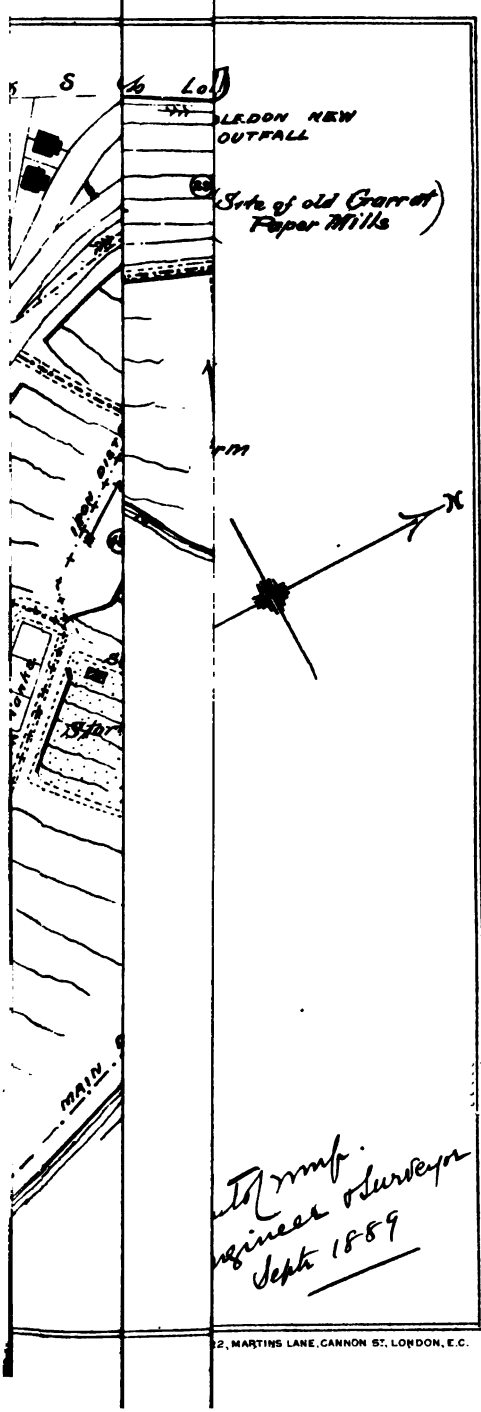

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PROGRESS IN OIL LIGHTING AT WIMBLEDON.

By C. H. COOPER, A.M.I.C.E., Assist. Surveyor to the Wimbledon Local Board.

In consequence of the many inquiries received from Town Surveyors respecting the lighting of the Wimbledon streets, the writer has thought it might interest the members of the Association were he to give a short account of the progress that has been made in oil lighting since Mr. Santo Crimp read his paper in 1885.

Several manufacturers, seeing that the Wimbledon Board, in common with the Boards of other districts, had determined not to submit to the exorbitant charges of gas companies, turned their attention to the improvement of oil lamps for street lighting.

Amongst the lamps thus submitted to the Wimbledon Local Board were Rettich's Mitrailleuse, Stringfellow's oil gas, Oxygen Light Co., Defries', and Cowdy Samuels'.

Defries' and Samuels' lamps are at present being tried in some of the main streets, and although they have their defects, yet they possess the following decided advantages over the flat wick and Mitrailleuse burners:—

1st. Saving in oil consumed per candle-power.

2nd. Saving in labour in attending, as lamps need not be filled every day.

3rd. There is no shadow thrown by oil reservoir.

Defries' and Samuels' lamps have each a main reservoir at the top of the lantern, capable of holding three pints of oil, sufficient to supply the former lamps while burning 35 and the latter 30 hours, i. e. for 5 summer or 2 winter nights. The oil is conveyed from the main reservoir to the small supply reservoir which feeds the wick of a central burner, by a syphon in Defries', and by two cotton wicks in Samuels' lamps. The level of oil in the supply reservoir is in both cases fairly constant, being regulated in Defries' by the arrangement of the syphon, and in Samuels' by a float in the

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supply reservoir which actuates a straddle to which the wicks are attached in the main reservoir.

The district is lighted from sunset to sunrise by 514 lamps placed at distances varying from 50 to 250 yards apart, the average distance being 100 yards. These lamps extend over 30 miles of roads and paths, and are lighted by eight men paid 1*l.* 3*s.* or 1*l.* 4*s.* each per week ; the foreman over these men gets 1*l.* 7*s.* a week, and has to do all repairs to lamps and lanterns.

The cost of lighting an average number of 480 lamps for the year ending the 25th of March last was as follows :—

	£	s.	d.
Oil, 22,176 galls., at 5·63*d.* per gall. ..	520	2	9
Sundries	30	0	0
Rent of stores	9	14	0
Chimneys	18	17	0
Wages	535	19	0
	£1114	12	9

Equal to £2 6*s.* 6*d.* per lamp.

The 514 lamps now in use include the following types :—

Number of Lamps in Use.	Type.	Wick.	Candle-power.	Oil Consumed per Lamp per Hour in Pints.
371	Empire	1⅜ in. flat	10	·08
100	Mitrailleuse	16 wick	30	·20
28	Defries	Circular	14	·08
15	Samuels	Ditto	20	·10
514				

The cost of gas and oil lighting compare as follows :—

Material Burnt.	Cost per Candle-power per Hour.
Gas at 3*s.* 9*d.* per 1000 cubic feet	·22
Oil (rock) used in Empire burner	·015
Ditto in Mitrailleuse	·011
Ditto in Defries	·010

The only brands of rock oil used are the Royal Daylight and Tea Rose, got from local tradesmen at prices that have varied from 4½*d.* to 5¾*d.* per gallon, the present price being 5½*d.*

Oil lighting has been adopted for street purposes at Wimbledon for eight years, and although in some respects not quite so satisfactory as that of good gas, it gives general satisfaction, and effects a saving of 1200*l.* a year on the rates.

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DISCUSSION.

The CHAIRMAN: Mr. Santo Crimp suggests that we should now, if there are any observations to be made, take the opportunity of making them. For my own part, speaking as a member of the Association, I may say that we are not mere sightseers, but we are here to investigate matters, and to determine upon facts. We have seen a very interesting process here to-day, and, so far as I can observe, it is very satisfactory. Some of the older members of the Association will remember that we went about the country many years ago, that we visited Leamington, Aylesbury, and other towns, and saw what in those days was claimed to be the very perfection of sewage treatment, the A B C process, and others. The promoters received us with hospitality, and we heard a great deal of eloquence. Somehow or other those processes have not kept to the front, and we have now another process put before us which also claims to be perfection. As members of this Association, we welcome every attempt to solve this great sewage question. We are most anxious to get at facts; but we do not get at the facts by approving notices in the newspapers. Upon the merits or demerits of the process we have seen, I have nothing to say, because I know nothing about it; but there is one question which has been asked me over and over again, and that is—"What quantity of lime is used in this process?" Lime is the old basis of all the processes. The number of patents for the treatment of sewage are legion, and they all turn upon lime with some variation. In this case Amines is the variation. I should like to know the quantity of lime which is used per gallon; and also the quantity of herring brine. The cost of the system is also most important. There is no difficulty about obtaining the purification of sewage. The clarification we can obtain by lime; the purification also we can obtain if we go to the cost. This new Amines process has had many good reports, and it has had unfavourable reports; but there may be partisanship. We all know that those who are interested in a process give one side of the question, and those interested in other processes give another. It has often occurred to me, and I have said it at these meetings before, that while the Legislature is so prohibitive and penal with reference to the pollution of rivers, it is a pity the Government does not assist us more as to what is best to be done. In America the State Boards investigate these

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subjects, and advise as to what shall be done. At home they tell us we shall not pollute the rivers, but they say nothing as to the best preventive process. We have had a Commission who have advised to go to the land, and when application was made to the Government, as at West Ham, to carry this out, the application was refused. We wanted to put our sewage on the land, and purchased a large area for that purpose; but the Local Government Board of the day refused our application and condemned us back to the tanks. With all these independent and conflicting schemes I think we should have a Royal Commission to report. At present we have Dr. Somebody retained by me, and there is Dr. Somebody Else retained by you—and professional evidence does not weigh for much when retained—but a Royal Commission could look into these things and put us in the right way. Going back to the paper, the author described a scheme which is very satisfactory at Wimbledon, and that being so I cannot understand why they should go out of their way to adopt a tank scheme which claims to be perfection in itself. With all this land I should have thought a rough and elementary treatment in the tanks would have been cheaper and sufficient.

Mr. THOMPSON (Chairman of the Local Board): The works are lent.

The CHAIRMAN: That answers my question.

Mr. GODFREY: I have been asked to give just a short explanation of the Amines process, and I must begin by answering almost the last remark made by Mr. Angell. He rather casts a slur upon Wimbledon, when he asks why Wimbledon, having a perfect scheme, should adopt this. The Wimbledon Local Board is a board of enterprise; they are not only quite satisfied with their own process, but they are also ready to give a trial to this or any other process. It is not a laboratory process. It has been in operation now for a week, and I believe it is to last on until the end of October. It is giving the system a trial which very few systems have been fortunate enough to obtain, and it is giving to gentlemen like ourselves an opportunity of examining and criticising the process. Of all the acute critics who will see this process, there are none more acute than the members of this Association; and if you cannot find a hole in it, nobody can. The average consumption of lime is 47 grains to the gallon, which is supplemented by three grains of herring brine. That same chemical can be found from other processes than the herring brine. At the present moment

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herring brine is the cheapest method of getting it, and there are ample quantities of it for meeting all demands. The herring brine is mixed with the lime in the mixing house. One of the points claimed for it is the rapidity of the settlement by precipitation; that means, as you know, a saving of tanks, as you can get your tanks emptied oftener. The alkalinity in it, owing to the large quantity of lime, is a point which must be met; but I think I am right in saying it is not up to the limit of the Rivers Pollution Act of 1875. The sludge you have seen, that has a smell, but it is not at all an offensive smell like you generally find about sewage works. What you have seen is worked entirely by the Wimbledon employés, and is being done to allow gentlemen like yourselves to see it working on a large scale, rather than by chemists in a laboratory. If there is one body more likely to suspect chemists than another, it is Municipal Engineers. The lime, I admit, is excessive; but you must put against it that you do not have to put any lime in to fortify the sludge after its precipitation. The cake you have seen lying out in the open air is the result of twelve chargings of the tank, and there is the sludge lying there perfectly inoffensive, so far as I can tell.

Mr. PRITCHARD: How many gallons a day have been treated at the present time?

Mr. GODFREY: Three-quarters of a million gallons per day.

Mr. SANTO CRIMP: No, not so much as that. The sewage in the gravitation tank is still treated by our own process. There is the sewage from 21,000 people treated here now by the Amines process. That would amount to about half a million gallons per day.

Mr. PRITCHARD asked as to the adaptability of the process to deal with varying conditions of sewage.

Mr. GODFREY: That is a question I asked the other day; how this process would be for sewage that was not purely domestic, such as from iron and chemical works, and paper mills? I was then referred to an experiment at West Ham, where a great portion of the sewage of Stratford is treated. That sewage contains the refuse of chemical works and factories, and the treatment was successful there in rendering the effluent sterile. Dr. Klein, in his report, says it was sterile, or almost as sterile as it is here.

Dr. ANGELL (Southampton): Can you tell me how much per cent. of methylene there is in the brine?

The question was not answered.

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Sir ROBERT RAWLINSON, C.E., K.C.B., who was received with hearty applause, said: I heard a few remarks when I came within, from my friend Mr. Angell, which I think I can explain to the meeting. He is apparently angry that his sewage-farm scheme was opposed by the General Board, and I believe I had something to do with that opposition, for being the chief Engineering Inspector of the Board, it came to me. It was vetoed, not from any antipathy to my friend, or antipathy to sewage irrigation on my part, but West Ham is in a peculiar position, and I knew, if he did not, that, as the West Ham sewers were laid out, the sewage might ultimately come into the Metropolitan main sewage carriers; and if there had been anybody at the Metropolitan Board with sound judgment, there never would have been opposition to its coming in. There is a mile of that West Ham sewer laid at a dead level, so that the sewage might at some future time be taken back, and be pumped into the Metropolitan main outfall sewer—the proper process, if the Metropolitan Board could have had one grain of sense put into its head. And, again, West Ham, as you know, is on the margin of the Thames and the Lea, and if any process on earth can make the Lea fouler than it is, I should like to know what it is. We will, however, pass from that. I have been exceedingly gratified to come down to-day and meet so many of my young brother engineers. I don't know whether it will be the last time I shall have the pleasure of meeting so many. I can only say I meet you with the greatest possible pleasure. I wish you, in your professional progress, all the success you may desire to anticipate. I am proud of the company that I am amongst; I am proud that I am a member of your Association. I am, I suppose, about the oldest Sanitary Engineer at present living. I have worked through from the very initiation up to the present time; I have also, with others, gone through an amount of opposition which I hope you may never know anything about, for the early opposition to sanitary measures reads something like a fable. To think that any men could be so bitterly opposed to what was ostensibly to be done for the good of our fellow men! I stand in one respect at the front of that progress. I laid out the works in the first town sewered upon the present sewerage principles, which I daresay you know. That is: that sewers shall be laid in straight lines and true gradients, and that when you change the line or gradient you should have a manhole with a movable cover for inspection, and that you should have ventilation sufficient to free the sewers from foul air. That

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ventilation has been a very difficult thing to accomplish, you must all know, as complaints have arisen, and complaints do continue to arise now; and it has occurred to me—and I hope you will pardon an old man, and not smile at what some may think absurd—that if I had a town to sewer now, and I had to use brick sewers or pipe sewers, I would take care to put ventilators in the crown of my sewer—not the entire length, probably, but we will say for 10 or 15 feet in length at intervals of 60 or 70 feet apart—perforating portions of the top of the sewer with small honeycomb perforations, over which I would lay gravel, and let any foul air that might arise in the crown disperse itself in the subsoil. I am perfectly certain that no injurious emanation could arise under the street that could do any injury, and it would tend to sweeten the sewer. I think a gentleman at Portsmouth has taken out a patent for something of a similar kind—that is, to carry a drain pipe through the crown of the sewer, connecting the pipe with a horizontal pipe along the top of his sewer. If, however, the crown of the sewer was porous, there would be no accumulation of gas. The bottom of your sewer must be watertight; that is essential, but I fear it is sometimes not fully carried out. The most difficult case in which to form tight sewers, and keep them clean, is in sandy, gravelly, or other porous strata, as a leaking invert either of pipes or bricks on such a subsoil, if only a very little of the water escapes, will leave your sewer comparatively dry, and the solids will be left there to accumulate and putrefy. The first essential is to have a sound watertight invert. Again, if you have springs in your invert, or along the side of your sewer, if they are not very large, take them into the sewer. I would rather have water, four or five inches in depth, flowing along a brick sewer invert than have a dry sewer. A wet sewer you may keep clean, a dry sewer you cannot. I have known some surveyors shut out all water. I have known other cases where the joints were so leaky that the pipe sewers were full of water. That is an error on the other side. Two towns I have in my mind have been as difficult as any in England to sewer—Oxford and Reading—because the land is full of water almost up to the surface. I believe, however, that both have been sucessfully sewered, and sewered in so able a manner as to shut out the subsoil water. There is a case where you cannot ventilate as suggested, and where you must have an absolutely tight sewer. Emanation of sewer gas can only take place at the ventilators, because all the sewers are absolutely water and air tight.

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Main sewers and house drains can be ventilated by pipes, never, however, less than four inches in diameter, carried up vertically above the houses; small pipes of one or two inches diameter are almost useless, and where used only bring discredit. With regard to the farm we have been over to-day, I don't think it is possible to see anything better arranged or cleaner. I am gratified beyond measure with it. But I see the carriers are laid with the rake of the ground. If I had to lay this ground out over again, most of the carriers should be laid level for given distances, with vertical falls, so as to give entire command of the effluent, to turn it on or off at any point. Of course there must be exceptions to everything. With regard to long lines of main sewers, I would not make them of one continuous grade, but give a fall at the manhole. In water conduits, bringing in water, I should also put all my carriers in level lengths, with vertical falls, and washouts at each fall in the conduit. When I was in Constantinople I went to a place on the Bosphorus where there are some great barracks for horse and infantry. Those buildings were given up to the British for hospitals, and they were bringing in water in an earthenware pipe on a contour line. A Royal Engineer was in charge of the works, but it had been left to a native to carry out, and I was inquiring if any arrangement for ventilation or washouts had been made, and he said he could not tell, he did not understand anything about it. One or two native workmen were standing about. I marked on the ground what I meant and one of these men came up, touched me on the shoulder, and intimated by signs that what I had shown on the ground had been done, and that in the East, from the very earliest time, water pipes had been laid on contour lines with means for ventilation and washouts. The idea that the ancients did not understand hydraulic laws, that is, did not know that water will rise to its level, is a perfect fallacy. I believe that from the earliest days they understood this law as well as we do now, as it would be utterly impossible to feel that a man could work with water and not understand this simple, self-operating law. It is true they had not the facilities for dealing with water as we have. They had not iron mains, but lead was the best metal they had to work with, so the largest pipe in use was seven inches in diameter, and if they wanted more water and had no stone aqueduct, they increased the number of pipes. If there was more pressure than the pipes would bear, they broke the line of conduit at intervals by vertical pillars, suiting the pressure from the surface reservoirs to the distributing reservoirs,

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and as they had not pipes and taps of small diameter as we have for distributing, they had a tank divided like a chess-board into a number of squares, and from every division a supply pipe was taken, and so nobody could draw more than his supply. This question of sewage with regard to London is a very important one. I don't know that I have any right to charge any particular man with wilfully doing that which is wrong, but I can only say that I am staggered beyond measure at what has been done and what is now being done. I can scarcely believe that any one would do what the Metropolitan Board has been doing, and is doing, at the main outfalls now. They have an area there of many acres (60), where they are putting the sewage sludge into surface tanks, and they have built most costly steam barges to take away the crude sediment and carry it down to the sea. Anything more cruel in the way of expenditure I cannot conceive—that sewage, which would flow anywhere, only find it a conduit, is barged down to the sea at what cost I cannot tell, by vessels which cost I know not how much. There is in that stuff they put in their barges never less than some 90 per cent. of water—I believe from 93 to 95 per cent. of water—and why barge from 90 to 95 per cent. of water down to the sea I cannot understand. There was a scheme propounded thirty years ago to reclaim the Maplin Sands. The conduit was laid out, and the estimate made. You can certainly reclaim 50,000 acres at Maplin, and I estimate that reclamation would not cost more than £10 to £20 per acre. You can then put the crude sewage of London there, without taking anything from it, for as many years as the world will last. I don't say you would get any great profit out of it, but you would get interest on your money, whether it cost one million or two millions sterling; as you could sell the sewage to any farmer that would take it, and I warrant that after one experience of it in a dry spring that farmer would want another taste of it. I would not ask the Metropolitan Board to buy one single acre more than was sufficient for their conduit, unless it was offered to them at the lowest agricultural values. Then they might take it with the certainty of doubling its value. You would have then, for the poor men who came up to London in winter, legitimate spade labour, where every man who came and said he was distressed could be put to work at 2*s.* and 2*s.* 6*d.* a day. What would be the result? I dare say you know I was sent to Lancashire to find work for the distressed cotton operatives. I was informed there were 40,000 people on the relief list. I had the

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distributing of 1¾ millions of money, and I went down determined to distribute that money in a way that the work should be beneficial, and I succeeded in doing it. I induced the Relief Committee to find a decent suit of clothes for every man who went on the works; that they should have the best contractor's prices, plus all materials found them; and that for six weeks after they went to work they should be subsidised by relief from the Committee they had been on. After six months the majority of these men were earning from 18s. to 25s. per week, and out of the 40,000 men on the relief books not more than 6000 or 6500 went on the relief works, and the others went we knew not where, for they drew no more relief money. If you have men that really can claim to be starving, what can you do with them? If you feed them for nothing they will be starving all the days of their life. But if you have 20,000 men who say they are starving, there will not be 10,000 who are honest; they are not made for work, and if it is offered them they will go away. But if you cannot offer them work you will have riot, and you will have money collected and distributed, doing more harm than good. The Government tried relief by work for wages during the Irish famine. They advanced eight millions of money, and it was admitted on all hands that if four millions had been taken into the middle of the Atlantic, and thrown overboard, it would have done more good; simply because the work was not of a useful character. I did not intend the Cotton Famine money to be distributed wastefully, so that every farthing of that money has been repaid—a thing never before done in the history of civilisation.

Professor ROBINSON: I wish to say one or two words upon the special object of our meeting here to-day, and I am sure I am but expressing the feeling of all present when I say that the fact that the Wimbledon Local Board has allowed these works to be used for experimental purposes is worthy of all commendation. Those who bring forward new processes have not often an opportunity, other than in a laboratory, of demonstrating the value of their process, but in works like this, where there is a large area of land, and where they are more or less independent of chemical treatment, it shows great consideration and great public spirit on their part to allow the experiment to be made. We are also greatly indebted to the Chairman, and to this Board, for what they have allowed us to see to-day. Only one word as to the process itself; I have no experience of it, except what I have seen last week and this.

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I, as an independent engineer, will welcome anything which is an advance on previous experience and knowledge. I cannot help thinking, however, that the old difficulty in regard to sludge will be found here. This is owing to the large quantity of lime used, which results in a bulky deposit of no manurial value. We are here to-day to criticise, and I hope what I say will not be thought to be uttered in a carping spirit. I feel the difficulty as to the sludge, and as to the alkalinity of the effluent. If that alkaline effluent passes into a stream, it is a thing which is prohibited, which has been objected to, and which will be fatal to any system adopting it. It is only fair to this system to say that Dr. Klein states its effluent is sterilised as to organisms. I do not know whether the effluent which runs from the tanks remains sterilised for any time; I believe it is able to absorb germs from the air which can fructify to the old extent, and become organisms to the old extent. I am certain it is a mistake to call the odour of the effluent a briny odour, because I do not smell about it that smell which I notice at the seaside. When Mr. Godfrey said that the smell from the works was like a whiff of fresh air from the sea, I noticed a commotion of surprise on the part of those who had not smelt it, and of astonishment, I will not say derision, on the part of those who had. It is a slightly diluted urinal smell which is associated in my mind; though I say it in no disparagement of it. I am told by a very good authority that the smell—although I classify it among the smells of urinals—really is a chemical smell, well recognised, and is associated with brine, or the seaside. I do not understand chemistry well enough to say whether he is right or I am right, and I am sure that we shall be glad to hear the inventor, and have his views upon the point.

Mr. C. Jones: I take a great interest in this experiment, but I feel it behoves us to exercise great caution in dealing with any new matter that may be brought up. We want to know all about the process. If it becomes a manufacture of chemicals for a thing of this kind, it throws us back on some very early schemes. Some seventeen years ago I was at Wimbledon on a similar errand. A scheme was then being tried here; the chemists swore by it. I may say it was turned out of my place at Ealing, but it went from here to various towns; it had thousands of pounds spent upon it, it had the impertinence to present itself before a Commission; but in the end it proved a most unmitigated failure. I remember that at

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Tottenham, a member of the Board said they were paying 10*l.* a ton for common salt. It therefore behoves us, as men who have to deal with these great questions, to be watchful and careful that we do not commit ourselves to the merits of a scheme of which we know little or nothing. The scheme was a scheme of tar, lime, and chlorine. Professor Frankland made a report upon it in February 1872, in which he said "the lime which is used is the only thing that is of any value in it." Lime is the component part, the most valuable part of all these processes, and if we are to pay a very big price for something that is added to it, we may be committing ourselves to something worth nothing. I shall welcome anything that may be brought to us dealing with the sewage difficulty, but we do want to know most thoroughly why we are to use 45 grains of lime per gallon, when 15 grains is considered a maximum, and when I, on my own works, which are not the least successful in England, use only 11 grains. When we were going on with our scheme, to which I have referred, I found certain difficulties crop up, and the gentleman who was making it—I am glad to say he was not an Englishman—said, "If you and I work together we can make lots of money." That was the secret of the scheme we were working. When we abandoned the scheme, we were threatened with a lawsuit, and we paid 10*l.* into court; I said, "He will be sure to take it," and he did take it. We want to get a good effluent, but we want to get it at the minimum cost; we want to get something that will be acceptable and that will be upon a sound working basis.

The CHAIRMAN: Sir Robert has said my scheme was not sanctioned because we ought to go into the Metropolitan system. I have always advocated that since I went to West Ham, twenty-three or twenty-four years ago; but the Metropolitan Board never would admit us, and between the Metropolitan Board and the Local Government Board we have been placed in a very serious position.

Mr. H. WOLLHEIM: I appreciate very highly the privilege you have given me to make a few remarks, and I shall not abuse that privilege by making any lengthy speech, but will confine myself to answering questions. The first one was with regard to the quantity of sludge. It was said—the more lime you use the more sludge you must make. The experience at Wimbledon is that in my process no more chemicals have been used than without it. I have used a great deal more lime in the initiatory stage, but I

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have saved the lime required for pressing. I challenge any gentleman who has any works under his charge to let me treat his sewage at the same price as he is treating it for now, if he is making as good an effluent as I am making. Our treatment consists, not of one single treatment, but we put in a quantity of lime and brine in the first instance, and after draining off the effluent from that treatment, we put in the second charge only a portion of that, and use the sludge for precipitation again. By repeated treatments, of which we have made ten here, the quantity of lime has been reduced to 47 grains per gallon, and in further practice I mean to reduce it still more. I have shown at large sewage works that I can treat with but 35 grains of lime per gallon. As to the quantity of sludge, I will undertake to make no more sludge than any other works are making at the present moment, and I ask you to give me the opportunity of proving it. As to the alkalinity of the effluent, I may repeat that the actual alkalinity found is below the standard of the Rivers Pollution Act. The effluent must have no greater alkalinity than that produced by adding one part of dry caustic soda to one thousand parts of distilled water. While that would be 70 grains per gallon in caustic soda, or 49 grains per gallon in caustic lime, the highest alkalinity that has been met with in the tests made at Somerset House with my effluent is 33 grains per gallon. Therefore I think I am right in saying that authorities using my process will not be taken to task for the alkalinity of the effluent. As to the odour, I shall not of course pretend to go into that. The official character that has been given to the odour by the eminent analysts that have had this effluent under their examination, including Dr. James Bell, of Somerset House, is "briny odour," "salty odour." Now, as to the important point which was made by another gentleman as to whether this process might not turn out to be similar to others that were announced with great flourish seventeen years ago and failed ignominiously, I, of course, have no knowledge of those systems. I went into the past history of the sewage question when I came here, but I could not follow all the old systems, the numbers are too large. I will say this in reference to my own, it does not make any high pretensions which it cannot sustain, but we are ready to show it, and to show it to gentlemen of such experience and judgment as yourselves, and let them decide for themselves. The same gentleman alluded to shares which had

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been offered him seventeen years ago. I have to state that we are not in the position of offering shares as yet. We want to prove the process fully before we do that, and when we have proved it, I daresay we shall do as others do, and go to the public. Now, I have been asked, "Can you get the brine?" I am proving that to you, and I should say the supply is abundant for all practical purposes, unless indeed all the sewered towns of England should be prepared to take up our process before the next fishing season; but that is an experience which I do not feel at liberty to anticipate. For all practical purposes the supply is abundant, and I can furnish it at 2*l.* per ton; but it may go up in price. If it should go up high, or the supply should be short, then science steps in to produce it, and, as anybody can satisfy himself, there are various substances from which the only ingredient of the brine required by my process can be produced, and it is sold all over the world in its pure state. Therefore I am warranted to think that the supply will not fail. As to the effluent, it has been proved by very severe tests—twelve consecutive precipitations in August, without removing the sludge. I ask any gentleman who is a judge, What more do you wish? I claim that the tests I have made, and made to satisfy every one who has seen them, are most severe; and if it stood those tests, and passed those tests, it is reasonable to say that it is a success. We have the opportunity of testing the process for another six weeks. There is only one more point to be demonstrated, that is, What will be the effect of the effluent on the land. As to that, no bad effects have been observed up to the present, but we must wait until the end of the period to show what effects it will have.

The CHAIRMAN: We have not really discussed Mr. Santo Crimp's paper. The principal point that struck me in the reading of the paper was the question of sewer ventilation. The author advises us strongly that the street manholes should be closed, and that we should ventilate as much as possible by shafts. I know Sir Robert has said in times past that we should get all the street openings we can, as it is better to have the gas in streets than houses.

Mr. W. SANTO CRIMP: It has afforded me very much pleasure to see so many of my brother officials here to-day. With regard to the works you have seen, and to the paper I had the pleasure of reading, I regret to find that the criticism has centered itself upon the Amines process; I had hoped that the sewage farm, and

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works generally, would have been freely discussed. With regard to the Amines process, I do not propose to say any thing about it on this occasion; I want to get at the facts of the case, and when I know all about them, I shall not hesitate to tell you the results, whether satisfactory or the reverse.

With regard to sewer ventilation, I am naturally very much gratified to find so eminent an authority as Sir R. Rawlinson agreeing with me, that ventilation at the street level is wrong in principle. Whether the method of making more openings, and then partially blocking them with gravel, as suggested by Sir Robert, or that of carrying ventilating pipes above the houses, as is done in Wimbledon, should be adopted, is a question for yourselves to decide. I think my plan is right; at any rate, we do not get any complaints from the residents, and that is something to be gratified at.

I do not quite agree with Mr. Angell that we should ask the Local Government Board to advise us on the sewage question. Those of us who have the charge of sewage works, and are in the habit of visiting them constantly, must best know the requirements of each individual case; and we should endeavour to find and apply the most suitable remedies.

There is no question here as to purity of effluent from our farm; I do not believe that any chemical process has ever been devised, or ever will be, that can produce an effluent equal in purity to that you have seen flowing from our farm. Our great difficulty lies in deodorising the sewage; in dry weather the sewage flow does not amount to more than 22 gallons per head, and then it is very difficult to treat. I have tried permanganate of soda; I have tried ferrozone—and an excellent material that is; I have tried carbon refuse, and other agents; but if these agents possess certain advantages, it will sometimes be found that—some of them at any rate—possess disadvantages which more than counterbalance the advantages.

With regard to sludge disposal, we are too near London to sell sludge cake, the market gardeners are glutted with stable manure; last year, however, we sold about a thousand tons at 1*s.* per ton at the works, this quantity was one-third of our total production. The cost of pressing is about 2*s.* 4*d.* per ton.

I had hoped to say something about micro-organisms, but time will not admit of my so doing to-day.

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After the reading of the papers, the members were hospitably entertained by the Chairman of the Local Board; after which they proceeded in carriages to the sewage farm, where the various works, including the Amines process, were minutely examined, and general satisfaction expressed at the excellent condition of the farm.

Votes of thanks were very cordially accorded to Mr. Crimp for his paper, and to the Chairman of the Local Board for the use of the rooms, and for his courteous and hospitable reception.

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DISTRICT MEETING AT ACTON.

April 26th, 1890.

Held at the Sewage Works, Acton.

H. P. BOULNOIS, PRESIDENT, IN THE CHAIR.

The minutes of the last Meeting held in the Home Counties District were read and confirmed, after which the following paper was read:—

THE ACTON SEWAGE WORKS.

BY D. J. EBBETTS, SURVEYOR TO THE LOCAL BOARD, ACTON.

THE treatment of sewage at these works consists of a combination of precipitation with filtration.

The sewage from the district arrives by two main sewers, high-level and low-level respectively. The high-level sewer arrives at the works at the level of 21·0 above Ordnance datum, and the low-level sewer at the level of 5·0 below Ordnance datum.

The combined sewage, from the two sewers, is delivered into channels where magnetic ferrous carbon, a material capable of precipitating and deodorising the sewage at the same time, is mixed with it at the rate of 6 grains per gallon, or 3 cwt. for the daily average delivery of 425,000 gallons. The sewage is then delivered to the precipitation tanks, and having been allowed to settle for 2½ hours, the supernatant liquor or tank effluent is allowed to flow over the filter bed, and the filtration effluent is carried direct to the Thames.

The sludge from the tanks passes by gravitation to a tank, from which it is pumped to the agitator, there mixed with the pressing powder, and thence delivered to the presses.

The pressed sludge is dried and ground, and sold at about 30*s.* per ton as manure.

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A Few Facts in Connection with the Works.

Amount of population contributing to the works, about	7,000
Average daily amount of sewage treated	425,000 gallons
Three precipitation tanks, each containing	150,000 gallons
Low-level sewage tank holds	64,000 gallons
Two filtration beds, each with a superficial area of ..	103 yards
Each filter consists of a 10-inch layer of "polarite" and sand, half and half, with a 6-inch layer of sand above, and layers of sand and ballast beneath. Thirty-four tons of "polarite" were used, at 4*l.* 2*s.* 6*d.* per ton delivered	140*l.* 5*s.* 0*d.*
The "ferrozone" or magnetic ferrous carbon, costs per ton delivered	2*l.* 5*s.* 0*d.*
Amount of pressed sludge produced every week	9 tons
Amount of ground manure per week	3¾ tons
Annual cost of sewage works, including labour, fuel, chemicals, water supply, lighting, and repairs—but not including sinking fund on original outlay, and not deducting proceeds of sale of manure ..	*1200*l.*

DISCUSSION.

The President: The sewage works we have seen to-day were started three years ago, when I had the pleasure of attending at the inaugural ceremony. Since that time I understand they have worked very satisfactorily. The effluent has never been found fault with; the filter beds, though very small, being only each a hundred yards of area, are filtering 425,000 gallons in the twenty-four hours. Of course, that is putting a great work on them, and, treated as filter beds only, it would be impossible for them to clarify that quantity of sewage in the time. It is plain, then, that we must look for explanation in the material of the filter which is used. It is more than filtration. In addition to the clarification through sand, the water passes through a bed of polarite, which accounts for the quantity treated. The polarite has been in existence here for three years, and has never been found fault with. The effluent we saw to-day I noticed had some flocculent matter in it. I asked what that meant, and I was assured it had nothing to do with the filter beds, but was due to the tidal water of the Thames backing up into the effluent. The paper was extremely short, but I have already pointed out the reasons for the shortness of it. Before

* The author has subsequently corrected this to 710*l.* See his remarks in reply to the discussion.—Ed.

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sitting down, I should like to propose a vote of thanks to Mr. Ebbetts for his very interesting paper, and for his kindness in showing us the works.

Mr. JONES formally seconded the vote of thanks, which was unanimously approved.

Mr. MCKIE: There is one point I should like to have information upon. Has the effluent been analysed?

The PRESIDENT: That is a question I have no doubt will be answered. I may mention that Dr. Angell, who is the consulting chemist of the Company, is present, and is willing to answer any question that may be put.

Mr. SAVAGE: I should like to know how so large a quantity as 425,000 gallons a day is accounted for from only 7000 people? It seems to amount to 60 gallons a day per head; I cannot account for that.

Mr. HODSON: Among other statements, I gathered, the total annual cost of this process was 1200*l.*, and the population 7000. These two figures seem to me, if correct, to show it to be a very expensive process.

Mr. BENNETT: I should like to know whether there is any quantity of rainfall treated at the works?

Mr. POLAND: I should like to ask whether the 1200*l.* per annum does not include the cost of pressing the sludge?

Mr. A. M. FOWLER: The first question that occurs to me is this—as to whether they treat the sewage continuously during the twenty-four hours, because if they do not treat the sewage during the whole of the twenty-four hours there is a great deal of time left for cleansing the filter beds when not in use. We all know that filter beds are so constructed that you can filter about 750 gallons per 24 hours per square yard. The Polarite Company claim to be able to filter a thousand gallons per 24 hours. If they only treat the sewage seven hours a day, it follows they will have more time to cleanse the filter beds, and do with less space. It may be they have a tank to take the overflow for part of the day. There is another point—the sewage at Acton is very weak. When a population contributes sewage at the rate of 60 gallons per head per day, the sewage is very weak indeed. We all know it usually varies from 25 to 30 to 40 gallons. If an engineer estimates for 40 gallons he gives a very liberal allowance. To my mind, this point requires clearing up. Well, of course, we all know that you can cleanse a filter bed very easily by skimming off the top portion

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of the intercepted matter; and whether it is a sand or polarite medium, the filter will last for any length of time. Therefore I do not think there is anything to claim for polarite as a special improvement. In waterworks the sand filters last for many years. The rest in the sewage, if they only work seven hours a day, will be such that it will almost amount to clear water. If that be so, there is little more to do than there would be in the ordinary waterworks filter. The small area of the filter beds is claimed as an improvement; but if they let the sewage rest, and only work seven hours a day, it is not a fair example for the country. Taking 750 gallons per square yard as a filtering medium for clear water from a river, which is fit to drink, and taking a thousand gallons per hour for this sewage—does it not naturally follow that it will soon clog up? If you can only pass 750 gallons of clear water, this effluent sewage would very soon clog up, and then it comes in again that you have two-thirds of the day to clear your filter beds. So you have a very large space of time to manipulate your filter beds. We all know that to cleanse your filter beds you must wash off the top stratum, and there is a good deal of labour in that, These are important points in my mind in working.

Mr. SMYTHE: I should like to know the amount of sewage which was filtered through the beds when they first started, and also the quantity that is capable of being filtered at the present time. I believe it is two or three years since the works were started. I want to know if there has been any deterioration, because I believe that is really the test to the ferrozone process.

The PRESIDENT: I am sorry to learn that Mr. Ebbetts, who read the paper, is not here, but I will ask Dr. Angell to reply to such questions as he can answer. With regard to the question as to what is filtered, I take it these beds are filter beds that are treating the whole of the sewage. If they were ordinary sand filter beds, an area of 637 square yards would be required. These beds only have an area of 200 square yards.

Mr. BAKER: I should like to know if this Company has had any experience with sewage that is largely charged with tan refuse, and brewery refuse, and how often these filters are cleaned?

Dr. ANGELL: Mr. President and Gentlemen,—I am much obliged to you and complimented by being called upon to answer questions, but I am not here to-day in any sense as a representative of the Company, or in any official capacity. I am simply one of your honoured guests, and have in no way prepared myself for address-

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ing you. Indeed, I did not learn until a minute or two ago, that Mr. Ebbetts was not here, and I was not listening with sufficient attention, even if I were able to answer, to all the questions which have been put. One of the first questions, however, was as to whether the effluent has been analysed. I believe I am within the bounds of truth and discretion, when I say that it has been analysed more than any other effluent has been analysed, and has been under the direct eye of the Government; they have sent their greatest chemists down from time to time; and Dr. Frankland has given a most excellent report upon it. He is, as you know, the most rigid disciplinarian of the present day as to sewage effluents. Sir Henry Roscoe has also issued a report upon this effluent, and given figures which indicate a very high class indeed. Then another gentleman spoke of the speed at which filtration is carried on at these works. I am not surprised at those remarks from those who speak only with a knowledge of sand filtration. There cannot be true filtration unless the filtering material is absolutely porous. There is a marked difference in water passing through the small spaces and between the solid particles as with sand, and in passing through the interstices and canals of the substance itself as in polarite. In such the operation of oxidisation, which is necessarily one of actual contact, can take place in a shorter time and within a smaller space. As to the activity of these beds, of which I have been asked, I can say they are more active now than when they were started. That seems to be a very startling statement to make, but it is so. I have no explanation to make of it, but one which is hypothetical at the present time. I am strongly of the belief, from some observations which I have made of the effluent, and upon the changes in its condition, that it becomes a biological bed as well as a filter bed. Those gentlemen who have had experience of filter beds which have been in use in waterworks will know that those beds are very often a mass of corrupt living organisms. The true action of these polarite beds, is, I believe, that in consequence of the amount of oxygen upon the bed, and in its pores, the kind of organism found there is one that produces nitrification. It is a fact, too, that the potentiality of the bed is purely recuperative. If it will go on, as it has done, unchanged for three years, there is no reason why it will not go on for thirty years, or three hundred years. There is sand under the polarite which catches any small particles which might otherwise be carried away. I know that in bringing before men qualified in dealing with

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filtration a product that has recuperative properties, I shall meet with some surprise. I am the pioneer of that scientific product polarite, and I was much pleased indeed to find on my visit to Acton that the activity of that very small bed seems to be not impaired in the smallest degree. I admit it is too small for the work it is intended to do. There are, as you know, things that come in, the purse strings are tied too tight, and you cannot do what you would wish. I should advise myself twice the area they have at Acton. I have been asked as to tan refuse and brewery refuse; whether this system has been brought to bear on sewage charged with such refuse. At Acton there is a large quantity of foul water from large washing and laundry establishments; and though that is looked upon as a simple matter, I am not quite sure it is not as difficult to deal with as excrementitial matter. We have had to do with the sewage at Swinton, where complaints had been made, and the sewage farm had become a perfect failure in consequence of the quantity of tan and brewery refuse coming down, and here the beds are acting well. As to the manipulation of the beds, I wish I had been sufficiently master of the facts to state how they manage the bed at Acton, how long it is going, and how long it is resting. But all the information is to be obtained from the Board itself, which is perhaps the safest source to obtain it from. I am absolutely proud to be the man who has been selected to be the scientific pioneer of polarite in filtration.

Mr. CANDY: Mr. President, I should, as Managing Director of the International Co., like to answer a few of the questions put at this meeting, and explain that the process at Acton does not cost any such sum as that mentioned, the entire cost of chemicals being less than 120*l.* a year.

The PRESIDENT: I regret there is no time to hear you, as we have to hear the paper from Mr. Jones.

Mr. LEMON: I am going to make a suggestion that Mr. Ebbetts should be asked to give some information of the cost of these works. I have known the works for three years, but have never been able to get a satisfactory idea of the cost. The works give the outside world the idea they cost an enormous sum of money. We are told that there are only 7000 people contributing to these works, and we have heard what is the annual cost. But a large proportion of the population of Acton goes into the Metropolitan system. If Mr. Ebbetts were to give us in detail what the works cost, separating the cost of the pressing, the ferrozone, and the polarite, we should

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then see whether, as is often stated, the works are the most expensive in the kingdom.

Dr. ANGELL: I wish to say one word in explanation as to the sanitary condition of the effluent. It has been watched continuously by the medical officer of the district, and I have had it reported to me since I have been in the room, that those reports are invariably favourable.

CORRESPONDENCE.

Mr. D. J. EBBETTS: The two principal points raised in this discussion appear to be (*a*) the large quantity of sewage delivered to these works from 7000 persons, and (*b*) the apparently large cost of the works.

(*a*) It must be remembered that a large number of laundries are connected to our works, and that a certain amount of sub-soil water and also a small amount of rain water enter the sewers. And though 7000 represent the number of persons inhabiting the houses connected with the works, still it is to be borne in mind that a large number of workpeople are to be found all day in the laundries to which I have referred, contributing therefore to the works, although for the most part their homes are not in connection with them, and to the same extent they are not included in the number of contributory persons mentioned.

(*b*) Having only recently been appointed to my present office, and having to prepare a few notes in a great hurry, I made use of some figures which I found, for the purpose of ascertaining the annual cost of the works. My attention having fortunately been directed to this subject, by your discussion, I have investigated the matter as thoroughly as possible, and find that the cost is less than I thought. In the first place, I found that the figures I refer to were based upon the estimated cost of the process when first entered upon, when 17½ grains of ferrozone per gallon were used; then I discovered that the entire salary of our superintendent was charged to these works, at which he spends very little time, as he is in addition the outdoor foreman for the whole of the District; that the whole of the pay of our two sewer flushers who fill out their time at the sewage works, was charged to them; and, amongst other things, that disinfectants used throughout the district, but stored at the works, were debited to the same account. It therefore became necessary to make a careful detail account of the cost, and having

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done so I find that it amounts to only 710*l.* per annum. This sum includes labour, fuel for pumping engine, lighting, water supply, chemicals, tools, repairs, &c., but does not include sinking fund on the original outlay, or any credit on account of sale of manure.

Mr. F. CANDY: The short paper read by Mr. Ebbetts did not convey a full description of the process, and I had not an opportunity to supplement it at the meeting, nor to correct the erroneous statement, that the International process costs 1200*l.* a year at Acton. We know by our books the exact quantity of materials used in the purification of the Acton sewage and give the cost of the same below. There has been no polarite supplied beyond the first quantity when the filters beds were made three years ago. The labour for mixing the ferozone, cleaning the tanks, and the surface of the polarite filter beds, as also pressing the sludge is done by two men and a boy, the wages for this labour does not exceed 3*l.* a week so that, as far as the International process is concerned, the total annual expense would be as follows:—

	£.	s.	d.
Ferrozone	70	10	0
Labour for tanks, sludge presses, and polarite filters, at 3*l.* per week	156	0	0
Annual expense for ferrozone and polarite treatment	£226	10	0

I am therefore at a loss to understand how the annual cost of the sewage works could be given as 1200*l.*

I understand that Mr. Ebbetts, on making a careful calculation of the actual expenses, finds that the total chemical cost at the works does not exceed 710*l.* per annum. This sum includes coals and engine-men's wages for the large pumping engines, provided for raising the sewage of a population of 50,000 to meet the expected rapid growth of Acton, so that the difference between the actual cost of the International process, viz. 226*l.* 10*s.*, and the 710*l.* is made up by cost of pumping the sewage, this expenditure of 483*l.* 10*s.* per annum has nothing whatever to do with the International process, and would have to be incurred for raising the sewage from the low-level area, even if it only had to be pumped into the Metropolitan sewer.

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DISTRICT MEETING AT EALING.

April 26, 1890.

Held in the Public Offices, Ealing.

H. P. BOULNOIS, PRESIDENT, IN THE CHAIR.

RECENT PUBLIC WORKS AT EALING.

BY C. JONES, A.M.I.C.E., SURVEYOR TO THE LOCAL BOARD, EALING.

IT is now some six years since I had the pleasure of meeting you in Ealing (shortly after the expiration of my term of office as President of the Association). The paper I then read was entitled "Twenty Years' Development of a London Suburb," and I am free to admit that it was with some degree of satisfaction I was enabled to point to the progress made between the year 1863, when the Board was formed for the better government of a country village, and the date of our Meeting, 1884, when the country village had grown into a thriving suburb—its rateable value having gradually worked up from the comparatively small sum of 17,500*l.* to the somewhat more important figures 118,000*l.* There were some who then felt that Ealing had reached its maximum and might fairly rest upon the work done; but a London suburb, if it is to maintain its position, can know no rest: "Progress" is ever its motto, "Full steam a-head" the order of the day; and this has been the policy of the governing body of Ealing, from the day of its formation to the present hour.

Some five years ago, circumstances pointed to the necessity for erecting an isolation hospital; and a very short period elapsed when a building, complete in every respect, was erected. Baths—which might also be used as gymnasium in the winter—next occupied attention, and eighteen months later saw them

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completed. The necessity for increased stable and store accommodation was felt, and the opportune moment was seized by the Board for carrying out these works. This happened in a most unexpected manner, by the acquisition of the splendid site of land upon which the buildings where we are now assembled are erected; and, I may add, the liberal owner gave me the opportunity of performing an act which does not often fall to the lot of a Local Board Officer. The land, with main road and side frontages, was valued at 3000*l.* I was allowed to fix a price at which it should become the property of the Board. I did it by cutting off the last cipher—turning the 3000*l.* into 300*l.* I need hardly say that, the owner having expressed himself satisfied, the Board were gratified; and even those who did not see the matter quite clear at first, have come to the conclusion that the step was a wise one, the principal factor in this all-round success being the very important one, from a ratepayer's point of view, that the rates have not been increased one farthing. With a death rate, upon a three-year average, of only 11·5 per 1000, with a loan account but slightly over one-half of the rateable value, and with a half-yearly rate of only 1*s.* 6*d.* in the pound (with a halfpenny for the Free Library), we have, to say the least, very much to be thankful for.

Turning now to the more immediate object of our meeting, I will give a short account of the circumstances which more immediately led to the erection of the hall.

No one who was present at the Jubilee celebration last year could well forget the enthusiastic way in which the day's pageant was carried out: few communities could outrival, and none surpass Ealing in its unique demonstration. There were not wanting, however, spirits who, satisfied with the demonstration, yet regarded it as of too transient a nature to be satisfactory to the loyalty animating them. Bonfires blazed, fireworks fizzed on that glorious day in June, and the Jubilee celebrations might have been over. But that was not to be. On the 25th January, 1887, a very large and influential gathering of the inhabitants took place, and E. M. Nelson, Esq., J.P., the Chairman of the Board, who had been elected Chairman of the Meeting, explained a scheme for the erection of the present building upon land belonging to the Local Board, but which the Local Government Board, who had previously been in communication with them, had said might be utilised for the desired purpose. The result was that a resolution was carried with acclamation, that a hall should be erected, and that, as

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suggested by the Local Government Board, it should be vested in the Local Board, as trustees for the inhabitants of Ealing; that the building should be used for the purpose of public meetings, balls, concerts, &c., and that the proceeds derived therefrom should be divided annually amongst charitable institutions in the district. A committee having been appointed for the purpose of carrying the resolution into effect, subscriptions for the purpose of raising the necessary funds to build the hall were solicited. Mr. Nelson headed the list with the sum of 500*l.*, and the appeal was heartily responded to by all classes. The committee were consequently able to carry out the desire of the contributors, and in less than two years, viz. in December 1888, His Royal Highness the Prince of Wales performed the ceremony of publicly opening the Victoria Jubilee Memorial Hall.

Concurrently with the erection of the hall, the Local Board built new Public Offices, and a suitable home for the Free Library. The latter institution had been located upon premises which were not so convenient or well placed as might have been desired, and it is a source of congratulation that a new and permanent building has been secured. The inhabitants of Ealing now have, upon one spot, in as near as possible the centre of the district, a block of buildings consisting of the Public Offices of the town, the Free Library, the Victoria Hall, the Baths, the Fire Station, the Stabling, and all other necessary adjuncts to the head-quarters of a local authority, such as, it is believed, is scarcely equalled, certainly not surpassed, in any other town in the kingdom.

The New Public Offices, Free Library, and Memorial Hall.

The design of the buildings may be described as English Gothic, freely treated to meet modern requirements, the details of stone-work being mainly based on the geometrical period of Gothic work. The principal entrance, both to the Public Offices and the Jubilee Hall, is placed in the centre, and above it is a two-storied oriel window, corbelled out from the main wall, and terminated by a pierced parapet, which forms the central feature of the whole design. To the right of this central gable is the tower, which separates the Public Offices from the Free Library wing, the height of the tower from the ground to the top of the finial being

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135 feet. The Library wing itself is treated in a manner somewhat plainer than the Public Offices, and terminates in a hipped roof corresponding with a similar roof at the west end of the frontage, thus giving a symmetrical character to the design, as far as the varied requirements of the rooms would permit. The entrance hall has a Doulting stone arcading, on red granite shafts, and from this the level of the Public Hall is reached by the central staircase of massive stone. Turning to the left from the entrance hall is the hall-keeper's office; beyond this, the general offices, Inspector's and Surveyor's offices; and on the opposite side the drawing office and two plan rooms, the inner one being fireproof. To the right of the entrance hall are the rate collector's room, office of the Clerk to the Local Board, the Accountant's office, and a private staircase. There is a second entrance to the Public Offices, at the west end of the building—a stone staircase leading to the hall, gallery, &c. The first floor landing of the main staircase has an arcading similar to that below, and on this floor are the Medical Officer's department, drawing office, three committee rooms, waiting-room, and the Board room, a spacious, lofty apartment, 45 feet by 25 feet, and 21 feet high. The features of this room are its open trussed roof, walnut dado, traceried windows, and oak boarded floor. In its rear are the members' cloak room, lavatory, &c. Ascending the back staircase from this floor is the way out to the whole of the roof, and to the record room and tower. The Memorial Hall—100 feet by 45 feet, and 40 feet high—has an open trussed hammer-beam roof, elaborately pierced. From the west end of the building there are two entrances to it, with a staircase on the right, and another on the left. One of these leads to the lower hall, which is 48 feet by 25 feet, and 14 feet high, and beyond that to retiring and cloak rooms. In the basement of the offices are the caretaker's rooms, testing rooms, stores, and strong rooms. Here also are the kitchen, office lavatories, &c., and the heating apparatus. The Free Library is approached by a single doorway, similar to the double doorway of the main entrance; on the ground floor are the reference library, the dimensions being 33 feet by 22 feet; the lending department, 39 feet by 20 feet; and at the north end is the reading-room, 32 feet by 26 feet. The whole of the area covered by these departments is half-basemented with two large class rooms for the Science and Art department, the centre being devoted to the library stores, with a lift to the lending department.

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On the first floor are two spacious rooms, respectively 23 feet by 22 feet, and 15 feet high; and on the second floor a splendid studio, 22 feet by 50 feet, and 14 feet high to the ridge, having an open timber roof and abundance of north light. The walls of the buildings are of Kentish rag, with Doulting stone dressings. The major portion of the woodwork used in the interior is polished American walnut and clean stained deal. The flooring of the corridors, hall, and landings is Diespecker's Roman mosaic. The roofing is of red Bangor slate and permanent green bands. Westphal's patent gas lamps are used for lighting throughout, and the method of heating is by Bacon's high-pressure apparatus. The buildings have been erected by Mr. Hugh Knight, of Morden, Surrey, to the design and under the superintendence of the surveyor of the Ealing Local Board. The loan raised for the Public Offices was 14,000*l.*; of this sum 7000*l.* was paid off within twelve months, from the sale of the old offices. The loan for the Free Library was 2000*l.*, and 400*l.* for Librarian's cottage. The cost of the Victoria Hall was 5000*l.*, including furniture.

Fire Brigade Station, Stables, &c.

At the rear of the Baths, and parallel to the Great Western Railway, are the various buildings connected with the brigade and stable departments. Facing Longfield Avenue, and adjoining the railway bridge, is a red brick structure with a tower at north-west corner—the new Fire Brigade station, accommodating steamer, manual, and hose cart. There are rooms for resident fireman, also large bedroom, furnished for two volunteer firemen, who take it in turns to remain at the station during the night; there is an accoutrement room, also used as a reading-room for the Brigade; underneath is a store-room. In the upper part of the tower is a large cistern; it can also be used as a look-out, and is so constructed as to form a drying place for the hose, which is drawn up to its full length, and effectually drained after being used.

Adjoining, and forming part of the design of these buildings, is the yard foreman's residence. Passing through the entrance gates into the yard, you have on the left a long range of buildings; the first are one story high, and consist of painters' and glaziers' shop, next carpenters' shop, and adjoining this the forge—the latter being a wonderful "economiser" in an establishment of this

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description. Over these one-story buildings are three 2000-gallon tanks, which are filled with water from the premises, and are used for flushing and road watering. Adjacent is a two-story building, the first portion of which is occupied by a gas engine, for cutting chaff, pumping water, &c., also the sewer deodorising apparatus, which has been found very useful in years gone by. Over this department is a bedroom, occupied at night by a stableman, who is also connected with the fire brigade; thus giving a contingent of five men (including the yard foreman), all sleeping on the premises or brigade station. This block also comprises a nine-stall stable, plain but substantially built, well ventilated, and fitted with every necessary appliance; the drains are outside the stable. Over these stables are the lofts and corn room. In conjunction with this block is a drying room, fitted with hot-air stove; in wet weather the collars, wraps, loin-cloths, &c., are placed in this room, so soon as the horses come in, and in the morning are found dry and fit for use again. East of and adjoining this is another block—a one-story building, also containing nine stalls; there is one loose box in each stable. On the south side of yard as you enter the front gates is the road engine house, and in the rear of it a mortuary; the building, for 5 feet of its height, is lined with white glazed bricks, and is fitted with the necessary appliances. Adjoining is a range of cart sheds, a trap house, and large room where men can cook their meals. We must not omit to call attention to the small paddock at the east end, nearly 200 feet long, where a horse can be rested for a day or two, and yet remain under the eye of the foreman. This plot of ground also provides ample scope for enlargment of stable premises when the necessity arises. We ought not to omit to point to the fact that on the paddock stands the unpretentious donkey-shed. Our two familiar friends, who occupy the shed, perambulate the town all day long, performing the duty of street orderlies; they come to the yard five or six times a day, and deliver their loads, which are taken to the farm every morning with the ordinary stable manure. The small cottage adjoining and forming part of the block, is the residence of the librarian of the Free Library. The amount of loan for the whole of stables and Fire Brigade Department was 4500*l*.

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The Baths.

By reference to the plan, it will be seen that the block of buildings forming the baths, are situate at the rear of the Victoria Hall. Being at no great distance from the Great Western Railway, special care had to be taken in order to prevent any difficulty arising from the tremendous vibration caused by the heavy broad-gauge trains. We are pleased to state that although having to do with a very sandy foundation, no difficulty has been experienced since the opening of the establishment in May 1886. Three separate swimming baths are provided, viz. "Ladies'," "First class men's," and "Third class men's," the dimensions being as follows:—"Ladies'": length 60 feet, width 24 feet, depth 3 to 5 feet. "First class men's": length 90 feet, width 30 feet, depth 3 feet 6 inches to 5 feet 9 inches. "Third class men's:" length 75 feet, width 25 feet, depth 3 feet 6 inches to 6 feet 3 inches. Each of the baths is fitted with diving platform, steps, dressing boxes, with seats, pegs, &c., for the use of the bathers. The doors of the dressing boxes are half the height of the boxes, the top portion being screened by a curtain, which can be drawn back at will, thus giving a much brighter and lighter appearance than the usual full height doors. In connection with the ladies' bath a large retiring room and lavatory have been provided, which forms a distinct feature of the scheme, and one which is much appreciated, as it is not merely an ordinary waiting room, but one in which the friends of bathers, or a nurse in charge of children, can pass away the time whilst those whom they accompany are in the bath. By the ticket office a room is provided in which the various clubs which make these baths their headquarters hold their meetings. The bottoms and sides of the baths are lined with white glazed bricks, relieved by dark blue lines and crosses, the whole having a very pleasing effect. Great care has been taken to guard against leakage, which has been a cause of serious loss and inconvenience at other baths, and for this purpose a bituminous composition was run whilst hot into a cavity between the glazed bricks and concrete wall, forming a lining thoroughly watertight. The passage-ways between the dressing boxes and the edge of the bath in the men's baths are covered with lead laid on boarding (this I do not advocate), and finished at the side of the bath with Victoria stone kerb. The ladies' bath has dressing boxes on one side only.

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The passage-way is covered with encaustic tiles, and kerbed with Victoria stone. Considering it undesirable to keep the three baths open during the winter months, arrangements were made for using the first-class bath as a gymnasium, the gallery round the same affording accommodation for some 500 persons. There are now two large athletic clubs who use the gymnasium during the winter months.

The engineering work in connection with the baths was carried out by Messrs. Thomas Bradford & Co., upon a system which has given great satisfaction in the numerous public baths fitted up by them, and consists in the present instance of two 20 H.P. Cornish steam boilers fitted in the basement, from which live steam is taken to each of the swimming baths, and fed, by means of perforated copper pipes (which have the advantage of maintaining a regular heat at any desired temperature), to the entire bulk of water, by keeping up a perfect circulation peculiar to the system, and obviating the unpleasantness of the discoloration of the water. For the convenience of the bathers, and cleanliness, the baths are fitted with brass handrail and spittoons. The dressing boxes are arranged round the several baths, and are heated by a steam coil passing along the entire length beneath the seats. The heating of the offices and waiting rooms has been effected by steam radiating coils, which can be easily regulated to give any desired temperature. The laundry in connection with these baths, used for washing towels, &c., has been carried out by the same firm. The laundry appliances consist of a Bradford's towel-washing machine, with rinsing, wringing, and boiling apparatus, and is worked by a 4 H.P. vertical engine, effecting a great reduction in the expenditure. The drying closet at the end of the wash-house is fitted with Bradford's improved draw-out drying closet horses, and is heated by a coil of cast steam pipe.

Little more than twelve months had passed when it was found necessary to erect slipper baths, and the first block was erected, facing the Longfield Avenue—still leaving ample space on the east side for a corresponding block when necessity shall arise. On the ground floor there are six slipper baths; on the one pair, four first-class baths, and two rooms set apart for cabinet Turkish bath. There is a commodious waiting room, and the various appliances for a first-class establishment have been provided. I need hardly say that the swimming baths, slipper bath, and gymnasium, are very largely used; and the fact that the average takings during

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the four years that the baths have been in use have amounted to the sum of 875*l.* per annum, is a tolerably conclusive proof of the necessity for their erection, and the immense boon they are to the community at large. The amount of loan for swimming baths was 8800*l.*, and for slipper baths 1500*l.* The cost for water is 220*l.* per annum.

The Hospital.

It might appear to some, at first sight, almost a superfluous work to erect an isolation hospital in Ealing, claiming, as we do, that Ealing is the most healthy of all the London suburbs, with the lowest death-rate, upon a three-years' average, of any inland town in England with a corresponding population. The Local Government Board had, however, pressed upon the Board for some time the importance of being prepared, and eventually the decision was arrived at to erect a suitable building, and directions were given to me to prepare the necessary plans, &c., for carrying out the work.

In looking over my papers for details such as might form the foundation of a descriptive paper for this day's meeting, I came across the account given in the *Middlesex County Times* of March 21st, 1885; and, as it has saved me a considerable amount of time and writing, I have, with my compliments to the editor, given it just as it appeared.

"Our Isolation Hospital.

"When the Chairman of the Sanitary Committee announced to the Ealing Local Board the approaching completion of its Infectious Diseases Hospital, he ventured to describe it as one of the most efficiently arranged and best appointed institutions of the kind in the kingdom. This description is literally true, and at the inspection of the hospital on Thursday, the Ealing Local Board established yet another claim to rank among the few local governing bodies who are fully abreast of the times, and promptly seek to use, for the advantage of those whose health is in no small degree in their keeping, the latest discoveries of medical and sanitary science. The medical gentlemen and clergy and ministers invited to be present at the opening, endorsed the Chairman's description very heartily.

"The hospital grounds have an area of about an acre and a half, are situate east of the cemetery, and are approached by a path through St. Mary's Churchyard, and by a new road from Ealing

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Road. The premises consist of four blocks—the matron's and nurses' residence, the hospital proper, mortuary, and ambulance shed, and laundry. Immediately inside the ground are the residence and offices of the administrative staff, and this building is sufficiently large to accommodate a nursing power equal to the wants of two additional hospital blocks. On the ground floor are the matron's apartments, the medical officer's room fitted as a surgery, store-room, kitchen, &c. Upstairs are four bedrooms, a bath-room, and a linen closet, with a hot-water system. The whole is admirably lit and ventilated, and a very neat and cheerful effect is gained by the use of Baltic deal, stained and varnished, for all the joinery. Just beyond the matron's and nurses' house is the hospital. The completeness with which the idea of "isolation" has been carried out is very apparent. The building raised upon piers, resting upon concrete, has an opening seven feet high under it. The floor of the hospital itself is of concrete covered with boarding, which, being finished with paraffin and white wax ironed in, is made impervious to moisture, so that it cannot take up anything like germs of disease. The hospital is approached by an iron colonnade with glass roof, and comprises five wards (capable of receiving fifteen patients) and a nurse's room, all of which open on to a well-lit corridor. The walls of each ward are of glazed bricks, circular at the floor and at the corners—lodgments for dust are altogether avoided. The bricks are for the most part of a French grey tint, but near the floor they are of a dark brown, the whole being relieved by a band of ornamental bricks at the chair rail. The windows are all of double glass, the intervening space being half an inch. This arrangement will prevent rapid changes of atmosphere being felt in the room. The ventilation is by means of an asbestos gas consumer, invented by the surveyor of the Local Board for this special work. The arrangement promises to be most effectual; for it is plain that, whatever infectious diseases may be in course of treatment, any germs arising would be completely destroyed in having to pass through fire. The inlet ventilator used is Ellison's, with small cone-shaped apertures. The nurse's room is in the centre of the building, and fitted with a small range, and with windows commanding three of the wards. The central ward, capable of taking two beds, will in all probability be available for those who can afford to pay for the special accommodation here provided. All the wards are 13 feet high, with coved ceilings, and the position of the building is such that in the course

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of the day each ward has the advantage of the sun shining upon it —a great desideratum in all such establishments. The hospital is exteriorly a neat brick building with red brick dressings, and what appear to be stone dressings for the windows, but really are concrete, manufactured from the results of burning the town refuse at the Board's works hard by. The building is covered with tiles, these being less affected by heat and cold than any other roofing material. There is plenty of room for the erection of two similar blocks, but we trust Ealing will never be subject to such a dire visitation as to render their building necessary. On the site reserved for one of the blocks, however, a concrete floor has been laid, about two feet above the level of the ground on a grass slope, and in the floor are bedded iron rings.

"In case of need, hospital tents could be pitched here, with accommodation for twenty patients, and after the crisis had passed the tents could be stored away till some violent epidemic called them into use again. Beyond the hospital block is a mortuary and an ambulance shed, and close by, but quite detached, is the laundry and disinfecting chamber. The latter is fitted with Dr. Ransom's disinfecting apparatus. The laundry is most complete in all its arrangements, having been fitted with T. Bradford and Co.'s washers, wringers, and drying closets, and furnished with an automatic flush of the most complete character. The drainage of the hospital has been most efficiently planned. It has no connection whatever with the sewerage system of the town, and the discharge passes direct into a special lime well at the Board's works, where it is separately treated. The grounds are enclosed with a brick wall, with a coping of concrete made of the same economical material as before mentioned. Throughout, there has been a very evident desire to give a cheerful and home-like look to the place, both inside and out. The grounds are prettily laid out, and planted with shrubs and flowering plants. The walls are covered with ivy and pyracanthus in alternation. This will have a very pleasing effect, for the latter plant has white blossoms in the summer, and scarlet berries to brighten the sombre days of winter. From the particulars we have given it will be seen that only by a great deal of thought and knowledge could a building so admirably adapted to the purpose in view have been secured for the district. The whole design, with its several specialities, is the design of the surveyor of the Board, and all who avail themselves of the opportunity of inspecting

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the hospital will congratulate him on the successful carrying out of the work. If there is never any need to use the hospital, so much the better for Ealing; but in case of an epidemic raging the district will be forearmed in the possession of an hospital, where patients will have the very best chance of battling with the disease, and of passing the period of convalescence with pleasant surroundings."

The loan raised for the land was 1500*l.*, and for the various buildings, enclosing walls, &c., 5000*l.*

Sundry Works.

Up to within the past three years, the communication between the northern and southern portions of the district across the Great Western had been by narrow and inconvenient bridges, which the increase of traffic rendered even dangerous. This has been remedied. The Castle Hill Station bridge has been widened some 20 feet, and the same work has been carried out with Longfield Avenue and Spring bridge; whilst St. Leonard's bridge has been entirely rebuilt at the cost of the owner of the estate on both sides of the railway, to which it is contiguous. The only old bridge now remaining, viz. Hanger Hill Bridge, the Board have decided to widen forthwith; so that I hope, before the year closes, the intercommunication between the northern and southern districts will be as complete as it can be made. Since your visit in 1884, miles of new and important roads have been made, and miles of private roads have been brought under the salutary influence of the 150th section, the 152nd section following in due course; and I think I may add that it is my firm conviction, that before two years have passed, there will not be more than one mile of private road in Ealing.

With general drainage work I will not deal, nothing very important having been carried out. The Sewage Works are much as you saw them on a previous occasion, and we simply remark that we have seen no reason to alter the mode of treatment which has been so successful for so many years. The Destructor, however, claims a word or two, although not in recapitulation of anything which appears in my Leicester paper upon that subject. The three new cells now erected are in some respects an improvement upon the old ones. My experience in the working of them has led me to effect improvements, which not only add to the comfort of the workmen, but the efficiency of the apparatus itself. They would have

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been at work to-day for the first time, but it has been suggested that it would be a matter of interest to some to see the actual construction, consequently you will find the old ones working, and the new ones open for inspection. I will say nothing about my child, the "Fume Cremator," except that it has behaved remarkably well, has travelled through various places in England, and is now making the acquaintance of New Zealand, Australia, the West Indian Islands, and Brazil. The multitubular boiler which has been in use since 1883 is now too small for the work, and a new additional one is about to be fixed. This will give me 50 to 60 H.P., working entirely off the Destructor, and will, I hope be an important factor in the lighting of Ealing with electricity, notice having been given to the Board of Trade that Ealing is on the track. The various parts of the District Fire Brigade, Police Station, Stables, Hospital, Sewage Works, &c., are now being brought into immediate communication by the telephone, and fire-alarm stations are being arranged.

At the stable yard, some few matters of interest to the sanitary officer will be found—amongst them being the Carter and Keeble street-sweeper, and a new type of water-van, which I have lately designed to do away with the nuisance so often found on a dusty day in connection with the present style of water van.

DISCUSSION.

The PRESIDENT: Gentlemen, I think we may congratulate Mr. Jones most heartily upon the beautiful works—for I may call them so—which he has shown us to-day. We may also congratulate ourselves that among our body there is a man like Mr. Jones, who is not only able as an engineer, but has shown such good taste as an architect. It is a matter of congratulation to ourselves, and I think a matter of congratulation to Mr. Jones. What we have seen to-day is the most complete thing of the kind I have ever seen. These buildings are practically in a ring fence; they are most complete in themselves, and they may be taken as models in every sense of the word. Mr. Jones has not told us—he has not told us publicly—the cost of these works, what is the total amount spent, or what individually the various works have cost. He is fortunately in the position of having a rich district. When we hear of a gentleman like Mr. Nelson, who has given 500*l.*, and more when we hear of gentlemen like Lord Rothschild, we envy Mr. Jones that he is in a district where money is easier

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to obtain than in districts which some other gentlemen are in. Personally, I wish to thank Mr. Jones for his paper, and for affording us this opportunity of meeting here, and I propose that a hearty vote of thanks be given to our old and esteemed friend Mr. Jones, for his paper, and what he has shown us to-day.

Mr. PARKER (Nottingham): I beg to second that vote of thanks.

Mr. EACHUS: I should like Mr. Jones to add the present rateable value and population. I know it is very small.

Mr. JONES: The present rateable value is 154,000*l.* It has gone up since I have been here from 17,500*l.* to 154,000*l.* The population is 24,500.

Mr. EACHUS: All I can say is it does Mr. Jones very great credit, with 154,000*l.* rateable value, to have carried out the works he has.

A MEMBER: The return from the baths is 875*l.* per annum. What does this bath cost to maintain per annum. We find in small towns, baths do not support themselves.

Mr. BROOKE: I have been very pleased with everything I have seen in Ealing, but I should like a word of explanation as to the baths. At Richmond, where we have the Thames, we lose by baths about 800*l.* per annum, and I do not know a place where baths are self-supporting. I should like to get at the full details upon this point. We are the adjoining town, and as I say, are losing heavily by our baths. I should also like to know the cost of the sweeping machine we saw, and if Mr. Jones finds any saving in the labour and materials, as scavenging is a great item in the keeping in repair of suburban roads.

Mr. WEAVER: I should like to know whether the eighteenpence includes the poor rate?

Mr. JONES: I am pleased to say I have nothing to do with the poor rate.

Mr. WEAVER: It gives an expenditure of 420*l.* a week, and you seem to do a great deal with it.

Mr. JONES: We do a great deal.

Mr. FOWLER: The third-class baths, I contend, should be free. The water and the river were originally intended for the people to bathe in and keep themselves clean, and where a wealthy corporation takes the water from the people, by building near it and for manufacturing purposes, I think the bath should be free.

Mr. BAKER asked how many tumbler carts were required to

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keep the sweeping machine going, and whether it was used all the year, both in dry and in wet weather.

Mr. CARLTON: I should like to know the quantity of water used in the bath, and how often it is changed?

A vote of thanks to Mr. Jones of his paper having been cordially approved,

Mr. JONES replied to the various questions put to him. He said: Mr. Brooke says that baths do not support themselves anywhere. He is perfectly correct in that. It is not altogether for a governing body to consider whether a thing is going to pay. The question for a governing body is to provide that which is absolutely necessary. You do not put up an Isolation Hospital because it pays. You provide it as a means to an end. You provide it because it is a necessity. The baths have been erected in order to meet a great want of the people, irrespective of whether they will pay or not. It is not a monetary matter with the Board. The fact that 50,000 or 60,000 persons pay for these baths every year shows they are doing something that is wanted. It pays indirectly in this way. The public works which have been carried out in Ealing have given us a name, and status, which enables us to require only a rate of 1*s.* 6*d.* in the pound, and that is the great answer to any question which may be put. All that has been done here has been done without any increase in the rates. The Free Library does not pay, but it is a splendid thing to have. The baths do not pay, but they pay their current account. I can only say we do not lose 800*l.* a year, or half that, and I would advise Richmond to go and do likewise. We have to pay 6*d.* per thousand gallons for water.

Mr. BROOKE: We pay a shilling.

Mr. JONES: There you have it at once. We change the water according to the weather. If the bathing happens to be very extensive the water is changed—once a week, it may be twice a week if it is required, but it depends entirely upon circumstances. We have no rule at all when the water shall be changed. Bathers do find out sometimes when it is changed, because they generally come in in flocks on that day.

A MEMBER: What do you charge?

Mr. JONES: The charge for the third-class bath is twopence, including towel and drawers, and the second and first class are 4*d.* and 6*d.* There is a reduction upon taking a dozen tickets, and we also arrange liberally for clubs. Those who belong to the

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gymnasium get their tickets still lower during the season. The sweeper cost, I think, 45*l.*, and it takes four tumblers, and with that you may clean up the greater part of your main roads.

Mr. WEAVER: The number of carts depends upon the nearness of the shoot?

Mr. JONES: Depends entirely upon the nearness of the shoot. It takes two horses to work it properly—it is cruelty to work it with only one horse. As to the general cost of the buildings, they have extended over six years. The stables cost 4000*l.*, the baths, 10,000*l.*, the hall 4500*l.*, and the public buildings, including Free Library, 16,000*l.*, from which may be deducted 7000*l.*, we got for our old buildings. So we managed to erect a very large block of buildings for what seems to be a very small amount.

The PRESIDENT: Under 35,000*l.*

Mr. JONES: And the fact that we have been able to do that without an increase of rates in Ealing, shows very great recuperative power indeed.

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GRAND JUNCTION WATERWORKS, HAMPTON.

By ALEXANDER FRASER, M. Inst. C.E., Engineer to the Grand Junction Waterworks Company.

The Hampton Station of the Company occupies an area of nearly 60 acres of land, and was established in 1852, at the time when, by Act of Parliament, all the companies supplying Thames water removed their intakes above the tidal influence. The Hampton intake is above Molesey and Teddington Locks.

The original works were constructed in 1852, and comprised an intake from the river into two settling reservoirs, and two direct-acting Cornish pumping engines, which lifted the water up a standpipe from which it flowed by a line of 33-inch pipes, 7 miles in length, to the station at Kew Bridge, where it was filtered and pumped to the district.

The works were enlarged from time to time, till in 1879 a separate system of supply was inaugurated to accommodate a large country district lying between Sunbury and Turnham Green, and a large storage reservoir was constructed, 10 acres in area and 45 million gallons capacity, to contain a supply of clear water during times of flood in the river, and filters were constructed in connection with a pair of 150 horse-power beam pumping engines, by James Watt & Co., for the independent supply of the country district through a new line of 30-inch pipes.

At the same time a system of underground filtration was established, in some of the spare land, which consists of clean sharp ballast and sand. This arrangement comprises a line of 24-inch stoneware pipes, with open joints, laid from the river into the gravel beds, with a slight inclination landwards; at a distance of about 200 feet, a double line of pipes of the same size and description was laid with open joints, at a rather lower level, not quite down to the London clay; these pipes were conducted to the well of a small engine house containing two horizontal engines, each having three-throw pumps, and together capable of lifting 12 million gallons of water per day into the reservoirs. The river

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water flows through the open joints of the pipes, across the 200 feet of gravel and sand, and is filtered quite clean, and it collects in the double line of pipes leading to the pump well.

The continual increase of population has compelled an increase in the pumping power, and as the original type of engine employed to pump the water to Kew has become obsolete, in favour of engines of a more economical description, the company are now erecting a plant comprising two low-lift engines, and two high-lift engines, with an aggregate pumping power of 500 horses, and seven Lancashire boilers—with a new intake higher up the river, on an island at Sunbury.

The island consists of gravel and sand, with an abundance of spring water, and pipes have been laid in the ballast, and arrangements made for taking water both from the river and the springs, and conducting it by a line of conduit, partly 36-inch cast-iron turned and bored pipes, and partly 48-inch concrete tubes made on the spot—to the pump wells of the engines, from which the low-lift engines will pump it into the storage reservoir, where it will deposit any matter in suspension, and after being conducted to the pump well of the high-lift engine will be pumped through a line of 36-inch pipes to Kew.

The engines are being manufactured by Messrs. J. Simpson & Co., of Pimlico; they are horizontal combined tandem engines, each pair having one flywheel, and the pumps are on "Reidler's" system with controlled valves. The boilers are being made by Messrs. Beeley, of Hyde, near Manchester, and are of steel, with a working pressure of 100 lbs. to the square inch. The pumping machinery will be capable of lifting 14 million gallons of water per day, from the river into the reservoir, and from the reservoir to Kew.

The iron pipes have been cast by Messrs. Cockrane & Co., and Messrs. Oakes & Co.; the sluices by Messrs. Simpson & Co.; the other ironwork by Messrs. Bartle & Co.; and the works and buildings are being carried out by Messrs. Aird & Sons, of Belvedere Road, Lambeth.

In connection with the increasing district between Sunbury and Brentford, a new engine has been lately erected by Messrs. Hathorn, Davy, & Co., of Sun Foundry, Leeds. It is on the diagonal principle, with high and low pressure cylinders, 100 horse-power, with Lancashire boilers; one of the boilers has been fitted by Messrs. Bryan, Donkin, & Co., with Perret's patent dust furnaces, to burn cheap fuel by means of forced draught.

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After inspecting the sewage works at Acton, which were explained by Mr. Ebbetts, the members drove to Ealing, where they were received by Mr. C. Jones, at the new Public Offices, and proceeded at once to inspect the stables, the fire brigade station, and the swimming baths. The party then went over the Public Offices, and the Victoria Hall, and assembled in the Council Chamber, where the discussion on Mr. Ebbett's paper was taken, and Mr. Jones' paper read and discussed; after which, at the invitation of Messrs. Jones and Robson, the party partook of luncheon. After being photographed on the steps of the Public Offices, the members drove to Hampton, where, by kind permission of Mr. Fraser, the large extension works of the Grand Junction Waterworks were viewed.

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DISTRICT MEETING AT HEREFORD.

May 17th, 1890.

Held in the Town Hall, Hereford.

H. P. BOULNOIS, PRESIDENT, *in the Chair.*

On the motion of Mr. Parker, seconded by Mr. Pritchard, Mr. A. T. Davis, County Surveyor of Shropshire, was unanimously re-elected Honorary Secretary for the Midland Counties District.

The following paper was then read and discussed:—

THE SANITARY WORKS AND WATER SUPPLY OF HEREFORD.

BY JOHN PARKER, ASSOC. M. INST. C.E., CITY SURVEYOR, HEREFORD.

THIS being the first visit of our Association to this ancient city, I purpose digressing somewhat from the ordinary routine of a paper, and to briefly allude to its Historical and Ecclesiastical, as well as its Municipal, Institutions.

HISTORICAL.

Hereford was the capital of Mercia during the Heptarchy, and was fortified by Athelstan with walls and six gates. In 1055 Griffith, a Welsh king, defeated Earl Ranulph, slew the bishop, seven canons, and the inhabitants indiscriminately, and burnt the cathedral and city.

Stephen is said to have been crowned in the cathedral, and during his reign the castle was held by the partisans of Maud; the city was constantly the scene of pillage, massacre, and con-

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flagrations. From its close proximity to the Principality, it has always been exposed to the inroads of the Welsh, but within recent years these invasions have consisted of nothing more formidable than armies of ponies and droves of cattle, for which our extensive cattle market provides a convenient outlet to other large centres of population.

Ecclesiastical.

The bishop's see was created in the time of Penda, King of Mercia, A.D. 680. Ethelbert was murdered here, at the instigation of Offa, who, in expiation of his crimes, built the cathedral, which was subsequently rebuilt by Bishop Athelstan in the eleventh century, but burnt by Griffith, a Welsh prince; the present cathedral was commenced in A.D. 1107, and added to by other prelates from time to time. The library contains some rare MSS., and a map of the world, said to be of the oldest in existence. By the courtesy of the Dean, I have made arrangements whereby any of the members who can spare the time can inspect this map.

Municipal Charters, Markets, Etc.

In Saxon times the bishops exercised civil jurisdiction, possessing many rights, such as holding fairs, taking tolls, &c. The first Charter of Incorporation, however, only dates from 1189, and was granted by Richard I. In 1382, the title of chief magistrate was changed from Bailiff to that of Mayor.

It is recorded that before the conquest of Wales, any Alderman found riding without an attendant, at a distance exceeding seven miles from the city, was liable to a heavy fine, the chance of his capture by the Welsh involving the risk of heavy ransom being demanded for his restoration.

In 1774, a special Act of Parliament was obtained for paving, cleansing, and lighting, the rate not to exceed one shilling.

In 1816, another Act was passed for the above purposes, and also for establishing markets.

In 1824, a private Act was obtained for lighting the city with gas, at a cost not to exceed that of oil, with a capital of 6000*l.* To this there had been much opposition by the tallow chandlers of the city, one of whom declared at a town's meeting, held in

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1820, "that if the city discontinued using Russian tallow, there would be no sailors for the navy, and we should be invaded. So strong was the opposition that at a meeting held on the 18th December, 1821, the following resolution was passed:—"It is the unanimous opinion of this meeting that the city should *not* be lit with gas." This unanimity evidently began to decline, for at a meeting on the 24th December, 1822, it was "resolved to light the city with gas, provided it can be done at the same price as with oil."

In 1854, the Hereford Improvement Act was passed for the erection of cattle markets, waterworks, and public sewers, with power to purchase the gasworks at a valuation.

A further Act was passed in 1872, giving the Corporation additional powers as to city improvements.

The Model Bye-laws were adopted in 1879; since then many city improvements have been effected, such as the extensions of markets, new streets, new outfall sewage works and sewers, a separate high pressure service of water for the higher and outlying suburbs of the city, which is also available in the event of fires, or other emergency throughout the low-level districts, particulars of which I will now proceed to lay before you.

Highways, Buildings, and Town Improvements.

Area.

The Parliamentary and Municipal limits of the city are co-extensive, containing 4670 acres, with 50 miles of streets and roads, 16 of which are main roads, for the maintenance of which the County Council have agreed to pay 1700*l.* per annum.

Granite, obtained from Clee Hill, Ludlow, at 6*s.* 3*d.* per ton, and 2*s.* extra for breaking to pass a two-inch ring, is used for repairs.

The 10-ton steam roller was obtained from Messrs. Aveling and Porter, about eight years ago, and has, I believe, saved its cost twice over, and made much better roads than formerly.

The net amount spent by the Roads Committee during the last three years has been—to March 25th, 1888, 5289*l.*; 1889, 4766*l.*; and 1890, 4923*l.*

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Pavements.

The side walks consist of almost every known and some "unknown" kinds of pavement, the cost being as follows:—

	s.	d.		s.	d.	
I. 3-inch York flags	—		..	7	6	per yard.
II. Stuart's Granolithic	4	0	to	5	6	„ „
III. Hall's Ferrumite	3	6	to	5	0	„ „
IV. Candy's Vitrified Bricks ..	—		..	4	0	„ „
V. Walker's Asphalte	3	0	to	3	6	„ „
VI. Asphalte by Corporation ..	0	3	to	0	9	„ „
VII. Cement „ ..	2	9	to	3	3	„ „

The cement pavement, as now being laid in Broad Street by our own men, is prepared as follows:—The bottom bed, 3 inches thick, consists of clean gravel and cement, in the proportion of six of the former to one of the latter, on a solid foundation, the surface or top coat being floated in 1¼ inch thick, consisting of 1 inch clean washed sand, Dalbeattie (or Clee Hill) crushed ¼-inch granite, and cement in equal proportions. The success of this pavement entirely depends upon the quality and condition of the cement. The specification in use is as follows:—

"The cement is to be Portland, of the best quality, ground so fine that the residue on a sieve of 5800 meshes to the square inch shall not exceed 10 per cent. by weight. A striked bushel shall weigh not less than 109 lbs., nor more than 116 lbs., the cement to be run through a hopper with spout 6 inches above top of measure.

"When tested, should the proportion which will not pass through the sieve be greater than 10 per cent., a quantity of cement proportionate to such excess must be added. When delivered, it is to be put into a dry shed at Corporation Yard, or store, and will not be accepted or paid for until it is tested by samples taken from different sacks or casks. About 10 per cent. of its weight of water shall be added and briquettes formed into moulds of 1 inch sectional area at the weakest point. The briquettes, having in the meantime been kept in a damp atmosphere, are to be put into water twenty-four hours after being made, and remain in water until tested.

"It must not, at any time of the year, set in less than 1 hour, and must bear, without breaking, a weight of 350 lbs. to the square inch fourteen days after the briquettes have been made. If it does not, it will be rejected, and must forthwith be removed from the stores by the contractor."

The cement tester used was made by Kuhlmann, four years ago, and I purpose fracturing a few briquettes in your presence.

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New Buildings.

No part of a surveyor's duty is more onerous than that involved in the supervision of new buildings. The Model Bye-laws were adopted *en bloc* by the Hereford Town Council, shortly before my appointment here, and although some may be shocked, you will *not* be surprised to learn that they have *not* been strictly carried out. I question very much if there is a gentleman in this room who has been able to do so.

The Public Health Act of 1875, and the Model Bye-laws following thereon two years later, are, by comparison with the previous Sanitary Acts, Amendment Acts, and Consolidation Acts, and so forth, as order is to chaos; still much is left out which ought to have been inserted, and much matter present which, in the interests of the public health, ought not to have been there.

Is there a Municipal Engineer present who correctly appreciates the distinction between a public sewer and a private drain? or who, having done so, has had the courage to carry the matter to its logical issue?

I recently wrote the following letter to surveyors of four neighbouring towns, inclosing a plan of proposed drainage to a block of six houses, as follows:—

"DRAINAGE TO NEW BUILDINGS.

July 5, 1888.

"DEAR SIR,

"A question has arisen as to the interpretation to be placed upon the 256th and following sections of our bye-laws whether each house should have a separate connection with the main sewer, or, as some suppose, the section would be complied with if a sewer is taken through several plots—at present belonging to the same owner—and a separate air inlet, disconnecting trap, and ventilator, placed off such sewer for each house.

"I enclose a sketch of the block plan, and should feel obliged if you would inform me if drainage, as set out by the red line, would be permitted in your borough.

"I am, &c.,

"J. PARKER."

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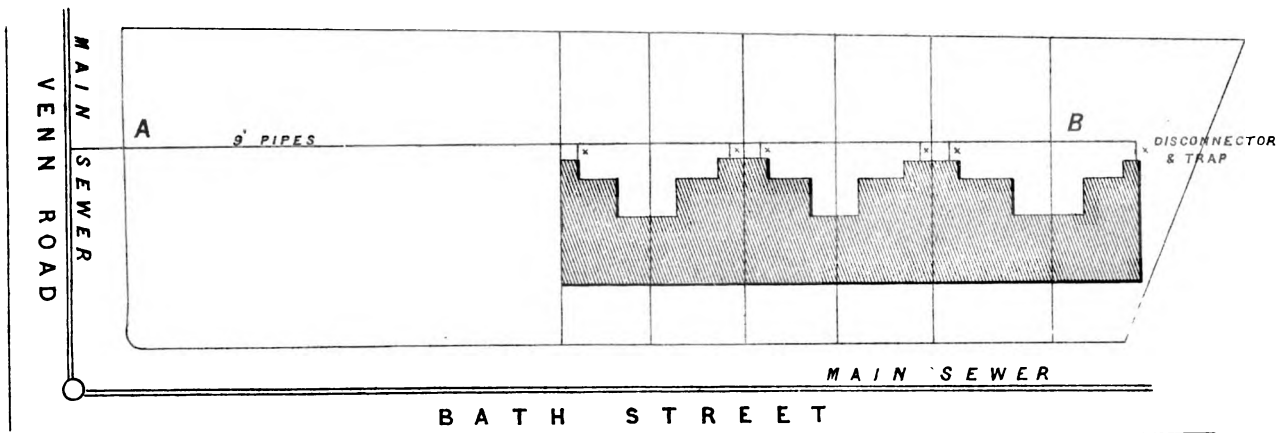
Plan of
DRAINAGE TO NEW BUILDINGS.



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"DEAR SIR,

"In reply to yours of the 5th inst. *re* Drainage of Buildings, I write to say the drainage of houses as shown on block plan would *not* be permitted here; we always insist upon all new houses having a separate drain to each house, so that each owner, present or future, can have direct access to the sewer, without going through any adjoining premises; we have sometimes allowed houses to drain to the back, when we have no sewer in the front, but then we always insist that an open passage-way free to all the houses be left over the main sewer, so that all parties may have access to the sewer. Under the present Act, if you allow the drain to be made as shown on your sketch at the back of the houses, your Board will always be liable to maintain the sewer, and compensate the owners and occupiers whenever you may be required to open the same.

"I inclose two forms, and remain

"Yours truly,

"———."

N.B.—*The names are withheld, as I have not had time to communicate with the gentlemen, asking permission to use their names.*

"DRAINAGE OF BUILDINGS.

"DEAR SIR,

"In reply to your inquiries of the 5th inst., the draining as marked on your plan would be permitted in this borough, provided the length of drain from A to B on plan, returned, had a ventilating shaft at B end of drain. The owner, or future owners, should be liable for the future repairs and keeping the whole of the drains in working order, including the length between A B.

"The difficulty will arise when the houses change hands, as to who is to keep the drain from A to B in repair and working order. We point out very clearly to the persons intending to build that it is not the duty of the Corporation.

"Yours truly,

"———."

"*Re* HOUSE DRAINS.

"DEAR SIR,

"In reply to your inquiry inclosing sketch of block plan of six houses fronting Bath Street, with a blank lot at corner of Venn

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Road available for one or perhaps two more, there is nothing whatever in the bye-laws sent with the plan to prevent the arrangement therein shown.

"The whole of the bye-laws Nos. 256 to 262 inclusive, refer only to the method of constructing drains, and are based upon the cumbrous and absurb model forced down our throats by the Local Government Board.

"The case you state comes under Sec. 4 of the Public Health Act, which defines the terms "drain" and "sewer" very clearly, and the "*sewer*" along the back of the houses comes under the definition, because it drains more than one house, while the "drains" are the short pieces running into each house. Neither the Act nor the bye-laws prohibit this arrangement, but by Section 13 of the Act all "sewers" are vested in the authority, and the spirit of the Act is in favour of one drain one house.

"Our practice under similar bye-laws is not to allow more than four houses upon one connection with the main sewer in the street. Thus, assuming the blank space at the corner to represent two more houses, or eight in all, four of them would drain at the back into Venn Road, and four be brought through to the front into Bath Street sewer; or, if the corner lots belonged to a different owner who objected to the drainage passing across his ground from his neighbours, there would be two connections to Bath Street of three houses each, and the corner two houses into Venn Road.

"The objection to the arrangement shown by you is, that it is capable of indefinite extension up to the back of Bath Street, and if the opposite side of the street is treated in a similar manner you then get three sewers to one street, two of them laid in odd lengths as houses are built, draining the houses, and the principal one in the centre of the road doing nothing but take the rainfall—a state of things that cost us 5000*l.* to abolish three years ago.

"Yours truly,

———— "R. READ."

"DEAR SIR,

"Replying to your favour of yesterday, if the drain at the rear of the houses is laid as shown on your sketch, it becomes a sewer, *vide* Sec. 4, Public Health Act, 'Interpretation of "drain" and "sewer."' If it becomes a sewer by reason of draining more than one house and not within the same curtilage, then it becomes vested in the Local Authority to maintain and cleanse; and if this

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is so, then it is no longer a drain to which your bye-laws apply. As to whether such as you have shown would be permitted here, I should say that, as shown, it is the most reasonable way of draining the property, and is far better than having a separate drain to each house, which would have to be laid under each building at a much greater cost.

"With regard to the disconnector and trap, I should in this case have a branch and gully for each house, with one ventilator at top end carried up above building.

"With kind regards,

"Yours faithfully,

"J. T. EAYRS."

The above replies are characteristic of the inadequate provisions of the law on this subject. No two carry out the bye-laws alike, and we differ from all.

Again, Section 25 (of the Model Bye-laws) enacts that when the external wall of a building is within 15 feet of any other building, a parapet wall should be carried one foot above the roof. This means that each and every cottage shall have a hideous, useless, and unnecessary monstrosity, with coping, lead flashing, &c., carried above the roof, and repeated, as you see in Eastern London and elsewhere, *ad nauseam*.

The clause as to timber in party walls, and brick facings for half-timber buildings, is a most arbitrary one, and would, if rigidly adhered to, eventually obliterate the beautiful half-timber buildings (an example of which you will see in the centre of High Town, called "The Old House"), of which we in Gloucester, Shrewsbury, Chester, and the Western Counties are so justly proud.

The difficulties which exist as to the 150th and other sections, would, if enlarged upon, extend my paper beyond its proper limits.

One of the important omissions is that a minimum height of rooms in dwelling houses is not fixed; this should never be less than 9 feet, still there is no power to reject a plan if living rooms should be shown 8 feet or even less.

It has been somewhere written that "God made the country, but the devil made the town." I would not go quite this length, although the inspiration which in the past has dictated the strength of roof and floor timbers, the quality of the mortar, the congested rookeries, defective drainage and ventilation, and other

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money-saving and death-dealing contrivances, can only be ascribed to the existence of an evil spirit which appears to have a particular affinity for that portion of mankind known as the "Jerry Builder," a Nemesis to Local Surveyors, from which, in Hereford, I am thankful to say, we are almost free.

With regard to the distinction between sewers and drains, I think in West Bromwich they have recently expended much time, and *some* money, in trying to obtain a legal decision on this point.

Sewage Purification.

The main sewers were constructed in 1854, under the direction of the late T. Curley, Esq., C.E., of this city, at a cost of 25,000*l*. The main line is of brick, 3 feet 6 inches by 2 feet 6 inches, with an average gradient of 1 in 350.

The ventilation until recent years was very inadequate, many districts having no ventilation whatever, others consisting partially of open gratings about 200 feet apart, in the centre of streets, some of the older streets being very narrow.

Seventy-three special shafts, surmounted by Boyle's extractors, Keeling's destructor, and other types, are now placed at dead ends of sewers and against buildings, the consent of the owners having, as a rule, been readily obtained thereto; and these have effected a complete remedy for the complaints made, as far as we have gone.

The sewage of Hereford is essentially a water-carriage system; I am not aware of a single cesspool within its drainage area. About half the district is drained by the old system of sewers, which are far from being impervious to subsoil water; the new system of sewers intercepts the sewage only, leaving the old sewers to take the rainfall and storm water throughout the districts intercepted.

In the new sewers there were laid:—

466	yards	of 2 feet	diameter	concrete	sewer.	
560	„	21-inch	pipe	sewer,	with	Stanford joints.
2134	„	18 „	„	„	„	
880	„	15 „	„	„	„	
4151	„	12 „	„	„	„	
3472	„	9 „	„	„	„	
1819	„	6 „	„	for	connecting	houses,

with manholes, lampholes, &c., and a 12-inch cast-iron syphon under the Wye, &c. Much of this work was done in quicksands, and the whole in exceptionally treacherous and difficult ground,

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involving the use of considerable quantities of timber and concrete, and enormous pumping appliances, the water level in the surrounding subsoil being often 9 feet to 16 feet above the invert level.

As we are in no sense a self-admiration society, but meet together from time to time to discuss (sometimes severely so) each other's work; and as I should certainly be asked later on how it comes about that we have so large a quantity of subsoil water, I will anticipate the question.

I do not know what the experience of other members may have been, but we have been unable to obtain a watertight sewer even with Stanford's joints. Constant supervision was given by the Clerks of Works, and in all sewers of greater depth than 11 feet they were, in addition, surrounded with 6 inches of concrete, notwithstanding which we had in March last by the Widemarsh Sewer 47,000, and by the Wye Valley section 85,000, together 132,000 gallons, per diem. This however, is a trifling matter by comparison with that which enters the old system of sewers. For instance, the sewage from the district drained by the new sewers adds but 212,000 or 344,000 gallons, and this in the flat low-lying and water-logged districts, whereas the remaining half of the city through the old sewers is now discharging 1,220,000 gallons per day: over 1½ millions together.

It is an interesting question as to how far it might be desirable to extend the separate system to the other parts of the city. On the one hand, we have to pump and deal with three-quarters of a million extra. On the other, I estimate the cost of constructing the separate system throughout, in order to exclude this three-quarters of a million, at 30,000*l*. I shall be pleased to hear what the experience of other members may have been on this interesting question, and also if an absolutely tight sewer has ever been constructed with Stanford joints on earthenware or stoneware pipes by any member present, in wet districts.

I will now pass on to the outfall works, which, like the sewers, have been constructed under enormous and unforeseen difficulties. The buildings and works were let to the late G. Moss, of Liverpool, and finished by Geo. Law, of Kidderminster; and the engines, boilers, and machinery, to Messrs. Hathorn & Davey, of Leeds. The storage tank is 100 feet by 100 feet by 15 feet deep, and intended to contain the night flow of sewage. But in the event of an abnormally heavy rainfall, the overflow upon the low level or

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osier bed would come into operation until such time as the pumps commence work in the morning.

The surface area of the five precipitating tanks is 17,888 square feet, and the cubical capacity 111,800 cubic feet = 698,750 gallons.

The area of the filter beds is 6½ acres, including the osier bed; if this should turn out insufficient, I apprehend no difficulty in acquiring by purchase or rental some of the adjoining land.

After precipitation, the effluent can be passed over either of the beds; the sludge gravitates to a tank, and by direct-acting pumps is lifted to the sludge cylinder, and thence to Drake and Muirhead's presses, which deprive it of 90 per cent. of its moisture, and it is turned out in cakes in the usual way.

Messrs. Hathorn & Davey have satisfactorily carried out their contract for machinery, which consists of:—Two patent differential diagonal compound high and low pressure surface condensing pumping engines, with pump, surface condensers, &c., each engine having jacketed cylinders 14 inches and 26 inches diameter, 26 inch stroke, with hand wheels for varying the grade of expansion, and differential valve motion of the most improved design, having large and small cast-iron subsiding steam cylinders; 3 feet cast-iron bucket pumps, 2 feet 4 inches stroke (buckets with percha packings and wrought-iron and leather double-acting flap-lids; two Galloway's patent steel boilers, 22 feet long and 66 inches diameter; one continuous sewage-mixing tank, 24 feet by 7 feet 1½ inches by 6 feet, having two sets of vertical agitating gear, 3 lime mixers, consisting of cast-iron casings with cast-iron pistons, pumps having cast-iron pistons, wrought-iron rods, and eccentrics for working ditto from main shafting, with wrought-iron clutches and gear for throwing in and out of gear, and cast-iron plug pipes with oak plugs for letting off; improved continuous sludge mixer, 5 feet 6 inches diameter by 6 feet 9½ inches high; four vertical sludge pumps having cast-iron rams, 3½ inches diameter and 6 inches stroke; two Drake and Muirhead's patent filter presses for sewage sludge, each with thirty chambers 36 inches inside diameter, and thirty-one patent filter plates; one Tangye's 10 horse-power vertical-driving engine; one Hudson's patent double-centre steel side-tip wagon, with 100 feet of 30-inch gauge 14-lbs. railway, with steel sleepers. The works were, in the first instance, designed by myself, E. Cousins, Esq., C.E., of 9, Palace Chambers, Westminster, S.W., being

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afterwards appointed consulting engineer. Many improvements and additions were, by his advice, embodied in the scheme, and throughout the relations between consulting and acting engineer have been of the most amicable and agreeable description. The cost of the whole has been about 36,000*l.*

Floods at Widemarsh.

The prevention of floods is, and has been, a difficult question in many towns, Hereford unhappily being among the number.

Widemarsh, in this city, as its name implies, is a flat plain of low-lying land, and was in ancient times usually covered with water, lying about 180 above Ordnance datum, receiving the rainfall from about 8000 acres, the outlets from which are very contracted.

The rainfall for the month of April last year was 5·23 inches. There was 48 hours' incessant rain from April 6th to April 8th; on the 7th the amount was 0·62, and on the 8th 1·71 inches.

I made a series of gaugings on the 8th, and I then estimated that 378 cubic feet per second was passing the most contracted portion of the channel leading to Widemarsh which the natural outlets were utterly incapable of conveying.

The limits of a paper prevent me from going fully into the detail I have suggested as a remedy; but the plan on the wall shows how, by the clearing and banking of the existing channels with proper gradients, and a short length of storm culvert, a recurrence of such floods may in my judgment be prevented in the future, the total cost being about 2000*l.*

The chief difficulty, however, lies in the fact that the Committee have no funds they can touch for such a purpose, without applying for a special Act, nor are they quite clear as to the portion—if any—brinkers on the lowlands, midlands, and uplands should be called upon to pay, nor the machinery which can be put in operation to compel payment.

Water.

The waterworks, like the sewerage works, are under the entire control of myself. They were originally constructed from the designs of the late T. Curley, C.E., and were opened in 1853, and cost 35,000*l.*, since which time considerable extensions have from time to time been made.

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Storage Reservoir and Filter Beds.

The storage reservoir has a capacity of 4½ millions.

The two filter beds have an area of 28,800 superficial feet, and consist of rubble stones to the thickness of 1 foot 3 inches, 6 inches of clean gravel (size of walnuts), 6 inches of pea gravel, and 12 inches of fine clean washed sand. The sand washer (which you will see at work), is by Lampitt, of Banbury; it is worked by a turbine with a head of 12 feet, its cost was 100*l.* The cost of washing sand is 7*d.* per cubic yard.

The cost of cleaning and repairing the filter beds, including washing the sand, for the three years past, has been as follows:—

1886–7	.. ..	127*l.*	5*s.* 0*d.*
1887–8	.. ..	179*l.*	14*s.* 5*d.*
1888–9	.. ..	102*l.*	11*s.* 7*d.*

The total expenditure on waterworks for each year has been 3654*l.* 18*s.* 5*d.*, 2874*l.* 5*s.* 8*d.*, and 2585*l.* 10*s.* 2*d.*, respectively.

The water pumped in 1886 was 230,330,022, and during the current year 212,575,660 gallons.

Pumps.

The pumps are in duplicate, of the bucket and plunger type; size 16 inches diameter and 30 inches stroke = 20⅓ gallons per stroke.

Engines.

The engines are of the beam type, by Simpson & Co. of Pimlico. The No. 1 engine was exhibited by them at the International Exhibition of 1851, from whence it was removed at the conclusion of the Exhibition to its present position, where it has ever since been at work. The second engine was fixed some few years subsequently. The indicator diagrams are not what you would look for in an engine of to-day, but having regard to the fact that their ages are respectively 34 and 38 years, their performances are satisfactory.

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Source of Supply.

The water gravitates to the sump by two conduits from the river Wye, and is strained through a copper strainer (sample exhibited). The total pumped during the past year was 212,575,660 gallons, as against 230,333,022 during the previous year.

Further than this, we have during the present year sold 8 millions more, of which the Great Western Railway Co. alone have increased their consumption this year by nearly 6 millions, chiefly owing to the increased number of long distance or express trains they are now running.

The question will naturally arise in your minds, how we can have pumped 18 millions less, and sold 8 millions more. This is accounted for in the all-important subject *waste*, which I shall again refer to. Our waterworks, being old, contain many defects which would not be present in works of more modern construction, but this renders them all the more interesting to a Municipal Engineer, whose province it is to evolve out of such a concern the best results with the least expenditure of money.

It is well known to most of you that in 1852 there was no such substance known, or invented, as Dr. Angus Smith's solution for preventing rust. I exhibit for your inspection samples of mains in which you will perceive their capacity has been reduced to one-fourth their original size; you will also see on the table samples of the ferrules and services then used, to which the same remarks will apply.

While the capacity for distribution was thus diminishing, consumption was growing apace—(*a*) by an increase of population, which was natural; and (*b*) by the increased facilities for obtaining water, which invariably leads to waste and increased consumption.

The water tower was commenced by my predecessor in 1881, who proposed to pump 11,000 gallons per diem by compressed air into a storage tank containing 20,000 gallons. The Committee, on my recommendation, abandoned this idea, and substituted a direct-acting pump capable of lifting 110,000 gallons per day, and the storage capacity being increased to 45,000 gallons at a total cost of 7725*l*. The roof of the tower was altered and arrangements were made to enable the full head of water to be utilised while pumping, and also to enable us to clean out the tank, or repair a

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plate or joint, without turning off the supply; in other words we can pump direct into the mains, without entering the tanks, in case of need. This was done, and the extra cost sanctioned by the Local Government Board.

The following is a copy of my report to the Waterworks Committee in January 1883, adopted at the February meeting of the Council in that year:—

"GENTLEMEN,

"In accordance with your instructions, I have prepared plans of the various alterations and improvements which it is proposed should be made in the distribution of water and prevention of waste; also provision for a new boiler, and for an improvement in the lighting of some of the principal thoroughfares; and have the pleasure to hand you the accompanying estimate and report:—

"The plan provides for a division of the city into five principal districts, for the following among other purposes:—

"The application of Deacon's waste meter system throughout the city.

"The utilisation of the high pressure service to any part of the city in the event of fire.

"Increased pressure and an improved distribution in the low pressure mains throughout.

"A reduction of the area of property deprived of water during necessary repairs, or connection for new services in various sub-districts.

"The ability to provide Fair Oaks Estate and other outlying high districts with an intermittent supply at a small cost.

"It will be seen that Whitecross district, involving as it does a new main from the pure water tank to Whitecross Road, is the most costly, and supplies at an increased pressure the four sub-districts—Broomy Hill, Cotterell Street, and the two sections of Whitecross Road. Cotterell Street will be disconnected at its junction with Whitecross, and the Above Eign district at the Barton railway bridge, and a 5-inch pipe substituted for the present 3-inch from Bath Street to Ledbury Road.

"The effect of disconnecting the Whitecross district will be at once to improve the pressure in the rest of the city; and by the substitution of a 5-inch for the present 3-inch main in St. Owen Street, the inhabitants of Ledbury Road, Bodenham Road, Foley Street, and Eign Road, will have a constant and abundant supply.

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"Each meter district is defined on the reduced plan, and the meters themselves are placed contiguous to the high pressure mains, and as central as circumstances will permit. The connections between the high and low pressure mains are regulated by sluice valves, back pressure valves being in each case inserted behind the point of connection. The meters themselves are fixed in each case on a bye-pass, with necessary sluice valves to enable the meters to be taken out for examination and repairs, without turning off the water. The meters are placed in front of the high pressure connections, to enable the difference of waste to be determined under either pressure, defective fittings being of course vastly more wasteful under a high than under a low pressure.

"I estimate the cost of the whole, meters included, at 785*l.*, as per annexed estimate:—

	£	*s.*	*d.*
New mains and water meters	785	0	0
New boiler	330	0	0
Sugg's lamps	150	0	0
	£1265	0	0

"Gentlemen, I am your obedient servant,

"J. PARKER."

The 212 millions of gallons, less 62 millions per annum by meter to railway companies, brewers, and others, and also for watering streets, &c., leaves a net consumption of 20½ gallons per head per day for domestic purposes, as against 30 gallons prior to the adoption of Deacon's waste meters.

The report and analysis of the water by the Medical Officer of Health on March 31st last, is as follows:—

"The quality of water supplied to your ratepayers maintains its excellent standard of purity, as by analysis made the 30th of March, 1890, it is:—

Total solids	7 per gallon.
Hardness	6·5 degrees.
Albuminoid ammonia	No trace.
Organic oxidisable matter	0·2 per gallon.
Colour, smell and taste, all that can be desired.	

"MANSION HOUSE, HEREFORD,
"*12th May*, 1890."

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DISCUSSION.

The PRESIDENT: Gentlemen, I am sure every one of us present has been greatly gratified at what we have seen here to-day, by our reception by the Mayor and Corporation, and by the admirable visit which has been arranged for us by Mr. Parker. With reference to the paper, it would be well if I were to make a few remarks now, and I will take them *seriatim*. There is one question with regard to pavement; Mr. Parker speaks of Hall's Ferrumite. The inventor of ferrumite was Mr. Greatorex, who was one of our members, and who was Borough Engineer of Portsmouth. I think it well to make it clear to the members that Mr. Greatorex was the inventor of that admirable pavement known as ferrumite. Mr. Parker also mentions asphalte pavements, at from 3*d.* to 9*d.* per yard. I suppose by that he means tar pavement. Even to make tar pavement at so low a rate as from 3*d.* to 9*d.* per yard, is very exceptional. On the question of new buildings, I may say that this paper deals with a vast deal of matter, all of it discussable matter, and it would be very difficult to draw the line as to what part of the paper shall be fully and adequately discussed. With regard to new buildings, there opens out an immense question in regards to the Model Bye-laws. I think Mr. Parker is correct in saying it is very rare that those bye-laws are carried out in any town. If they were, architecture would be greatly crippled by the laws that are there laid down. I will not say more, because it would take a great deal of time to mention the points where I disagree with the Model Bye-laws. Another discussable point in the paper is the question of house drains, and when a drain becomes a public sewer My opinion is, and I have given the matter considerable thought, that section 4 of the Public Health Act, which defines the terms drain and sewer, is quite sufficient for that purpose. Under that section of the Act, the long line of pipes between A and B on the plan is a sewer in the meaning of the Act, and after it is drained, and after the separate houses have come into the possession of different owners, no doubt it becomes a sewer repairable by the public authorities. As regards the muddle as to the 150th section, I entirely agree with Mr. Parker that if enlarged upon it would extend his paper beyond its proper limits. We could spend two or three days discussing the Public Health

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Act. One point with regard to ventilation; Mr. Parker says, "Seventy-three special shafts, surmounted by Boyle's extractors, Keeling's destructors, and other types, are now placed at dead ends of sewers and against buildings, the consent of the owners having, as a rule, been readily obtained thereto; and these have effected a complete remedy for the complaints made, as far as we have gone." I think, as regards the experiments which have been carried out with shafts, that the open shaft, cutting off the gas as it rises, is more effective than any other form of extractor, except where heat or some of those other mechanical forms of extractors are used. With regard to the subsoil water entering Mr. Parker's sewers, in that again he is perfectly correct. It is very difficult to make a watertight sewer of any kind, and especially so with a pipe sewer. He has used Stanford's joints. Well, gentlemen, I have no doubt many of you have used Stanford's joint, and Stanford's joint does very often fail, and it is evident it must fail when we see the construction of that joint. It is a single joint, and a frictional joint, and must fail. There is a joint just come into the market—Hassall's joint—which is a double bearing joint, and the most perfect joint that is at present known to us. There is one point with regard to the pumping. This engine we saw, by Messrs. Hathorn & Davey, is a new type to me, and I daresay it is to many of our members, and I do not see anywhere in the paper that we have the indicated horse-power. We have seen a great deal that is of interest to-day. I will leave other members to speak of the sewage system; it is small but complete. The filtering area is also small for the number of inhabitants. I believe I am correct in saying that the population of 20,000 persons drains into the works, with only 6½ acres of filtering area. If the filters continue to do the good work they are doing now, I have no hesitation in saying they will be a great success. I have very great pleasure in proposing a vote of thanks to Mr. Parker for his paper, and for the interest he has always shown in the Association.

Mr. E. PRITCHARD: As an old member of the Association, I must first of all thank Mr. Parker for the paper which he has been good enough to prepare—a paper containing many points of interest, and I think to many of us some points of instruction. It has been certainly a great pleasure to myself, and I feel it must also afford similar pleasure to the gentlemen I see here; and I think we may congratulate the Corporation of this ancient city of Hereford in having so energetic, able, and industrious a City

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Surveyor as Mr. Parker. The President has hit upon the most important points in connection with this paper, and it is not my intention to take up your time in a criticism of the works beyond a few remarks and also probably a few questions. It has always been an object of considerable interest and importance to Municipal Surveyors to know the cost of the roads of the various towns that they are in. We have had, on page 66, a statement as to the cost in 1888–90. I think it would be instructive to know the length of time, with the traffic in Hereford, that a street of ordinary macadam will stand, or in other words, how soon it requires renewal; and secondly, the cost per square yard per annum. Respecting cement, I note the author, like all engineers who are desirous of having good work, is determined to have good material. I would wish for a moment to digress, particularly as our President comes from the important city of Liverpool, as in that town a predecessor of our worthy President adopted a system of cement testing and cement cooling, which I have found useful. I have adopted in some large works the system of Mr. Deacon, a former City Engineer of Liverpool, and a Past President of our Association; that is, to have a cement-house built with ten movable floors, each floor having a vertical space of about ten inches. I will explain its working briefly. Every floor is equal to the daily use of cement in the works. The first load is placed upon boards that are clinker laid; that remains twenty-four hours. The next morning these boards are turned over, with the natural result that the cement falls to the second floor; another load is put on, and the operation repeated every day, with the result that by the time it gets to the bottom it has had ten days' exposure, which gives the best results in Portland cement. I have found this plan of value, and probably many other gentlemen have. A very interesting question is raised by Mr. Parker as to house drains, and what is a public sewer and a private drain. I have looked at this matter from the stand-point of the Local Government Board, who define a sewer as a conduit through which sewage flows. I do not quite agree with Mr. Parker as to the building of party walls; I certainly am in favour of those walls being carried through the roof, because if they are properly constructed there is less chance of fire destroying the house adjoining than there can be with the division wall terminating below the slates and plaster. With regard to subsoil water in sewers, I have had very great difficulties in various parts of the kingdom in making tight sewers. I have succeeded

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in making tight sewers with cast-iron pipes with lead joints. If the Hassall pipe is jointed properly, it is a perfect pipe; but if it is not perfectly jointed, it is like everything else, and very often has the discredit attached to it that rightly belongs to imperfect work. I agree that it is necessary to have a tight sewer; certainly in quicksand it must be tight. I have much pleasure in seconding the vote of thanks to Mr. Parker for the paper he has given us, and for the great interest it has given me personally.

Mr. J. Lobley: I have very great pleasure in supporting the vote of thanks to Mr. Parker. His paper touches upon many points involving considerable discussion. The drainage question is very important to most of us, and I think there is no doubt, if the sewer marked A to B on the plan is put in with the approval of the Authority, it becomes a sewer repairable by the ratepayers. Where it has been done against the wishes of the Authority I have required as a condition before connecting to public sewers that the owner should give an acknowledgment that it is a sewer laid for his own profit, in other words, to save him the greater expense of separate drains. Mr. Pritchard gives the common-sense view of the difference between a sewer and a drain, but the Public Health Act distinction is not a common-sense one, but says a drain, if it drains one house only, is a drain and not a sewer. The Model Bye-law requiring party walls to be carried through the roof is no doubt framed to prevent the extension of fires. However this may be in London, it is quite unnecessary in provincial towns and for cottage houses. They are very unsightly, expensive, and difficult to keep water-tight. Fires of the kind contemplated are unusual; in fact, for 20 years I have had no instance of one, in a large and populous district, where such a provision would have been of any use whatever. I certainly think the height of living rooms in dwelling houses ought to be included in the bye-laws, and I agree with Mr. Parker that they ought to be at least 9 feet in height. I do not agree that there is any muddle in the 150th section of the Public Health Act. It has done excellent service, but it is on the whole too rigid, and we would all like to see it improved. Members will find this subject fully discussed at the meetings at Rochester and Warrington, on Mr. Spinks' paper. With regard to the works we have seen to-day, I have been much pleased with the pumping engines, and have always been greatly interested in Mr. Davey's inventions, which the members have previously seen at Croydon, Chiswick, and Hampton.

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The sewage presses are also satisfactory, but the system of mixing the lime by means of rotating agitators cannot claim to be an improvement on the liming mills introduced by General Scott about ten years ago. [For fuller description, see volume vii, page 64, of our Proceedings.] By this mill the lime is insured to be ground into fine division with water, which then joins the discharge from the pumps. By this waterfall velocity, assisted by baffle plates in the conduit, the entire volume of sewage is thoroughly well mixed with the limed water. Very considerable power is expended here in the comparatively slowly-moving agitators endeavouring to plunge about a large volume of sewage. Something of this kind is a necessity where there is no pumping; but with such a fall from the pumps to the tanks as exists here, such arrangements I think are superfluous. I find with the Scott liming mills, 7 to 8 cwt. of lime to the million gallons of sewage is sufficient. This is a much smaller quantity than at any works I know using the slow agitators, and I attribute this to the extremely fine state of the lime and the thorough incorporation with the sewage. Nothing is to be gained by using more lime than is found sufficient to precipitate the solid parts of the sewage, particularly where land filtration is afterwards resorted to. The arrangements for the tanks and filtration area are very good, and Mr. Parker and the Corporation are to be congratulated on the effluent water.

Mr. A. T. Davis: I should like to ask Mr. Parker whether it is proposed to crop the filter beds. Then, with regard to open ventilation, I quite agree with you, Mr. President, that the open ventilators for sewer ventilation are better than those with cowls and such like extractors. I have had experience with a great number of them, and they have all answered very satisfactorily indeed. With regard to party walls being carried through the roofs of dwelling houses, I believe as a means of preventing the spread of fire, it is a very admirable plan; but in small cottages it is expensive, and seeing how very few cases there are of fires caused by the spread of fire from one cottage to another, it is, in my opinion, quite sufficient if the wall is carried right up to the slates or other roof covering, free from woodwork, including laths. With regard to subsoil water in sewers, Mr. Pritchard quoted a speech of Sir Robert Rawlinson where that eminent engineer advocated subsoil water as an advantage rather than a disadvantage. I think, at any rate with the upper ends of sewers, those sewers which receive very little sewage, that it is really a positive advan-

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tage that subsoil water should be admitted into them. Subsoil water has this advantage over surface water, that it is constant, whereas surface water is inconstant, and it is that constant flow of water we require to flush our sewers. I should like to add my testimony to that of the other speakers in thanking Mr. Parker for his admirable paper.

Mr. R. READ: As the writer of a reply with regard to house drainage, I should like to thank Mr. Parker for the paper, as other members have done, and to call attention to the plan given with the paper. The system shown on that plan is the one advocated in 1852 by the General Board of Health in London, the predecessors of the Local Government Board, of which Mr. Austin was the engineer. The Local Government Board has reversed that system altogether. In Gloucester, we had a number of these cases in what is called the added part of the city. The city was extended in 1874. At that time the houses were drained in this way, into culverts which were simply laid in the beds of ditches. Where they converged on the streets—when the new system of sewerage was laid—these drains were connected. As the contractor came along he would connect them as shown on the plan in the Venn Road. The Corporation trusted to the owners to remodel their drains, but the result was that they did not do so, and in 1885 the whole of that work had to be done by the Corporation. Back drainage is a most objectionable system, because, as I point out in my letter, the drain is begun at one end as two or three houses are built, then others are added, and you have a 6-inch pipe draining perhaps twenty houses in a street, and finally you get three sewers doing the work of one sewer. With regard to the bye-laws as to party walls, I think with Mr. Davis that if a 9-inch wall—and you cannot legally build anything less —is carried up to the slates, it is sufficient to protect the house against fire, without breaking through the roof, and having unnecessary coping and flashing above the roof, which every one tries to get out of, jerry builders particularly. It is very objectionable that the bye-laws do not provide for the height of rooms; we take 8 feet as the minimum height. Another great difficulty in the bye-laws is with regard to temporary buildings; they are so very stringent against temporary buildings. A temporary building is run up in a night, and you don't know it is there until the next morning, and then the thing is how to get it down again. The owner goes round to the members of the council, he button-

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holes them, and gets them to say it shall not be removed, and very great difficulty ensues. Where a man is starting a business, he does not want to put up a building of bricks and mortar, but often wishes to put up a temporary building to see whether the business will be a success or not, and it is a pity the bye-laws do not provide for such temporary buildings. With regard to the subsoil water in sewers, where the subsoil water gets in it means so much more expense in pumping, and the sand follows the water, and instead of cleansing the sewer simply silts it up, and you have to get the sand out in some way, unless the sewer has a very great fall. With regard to open ventilating, I have 600 6-inch ventilating shafts. I started to put cowls upon them, but speedily took them off again.

Mr. J. PARKER (Nottingham): I wish to support the City Engineer of Gloucester in his objection to subsoil water being utilised for flushing sewers, because if the subsoil water is allowed to enter the sewers through the joints, the question is how is the quantity of water which finds its way into the sewers to be limited? Then, the sand will enter the sewer where the water enters, and you are all aware how disastrous it is to the working of the sewers if sand is allowed to enter them. A still further, and more serious matter is, that where water can get into the sewer, sewage can equally escape, which from a sanitary point of view is most objectionable. I was pleased to hear the President of this Association, the City Engineer of Liverpool, say that he had found an absolutely water-tight joint in the Hassall joint, even where subjected to the severest tests. This is also the experience of engineers who have used very large quantities of the Hassall patent safety jointed pipes in the very worst ground in England; for instance, Mr. Bromley has used 16 miles of these pipes at Hounslow, in running sand and water, with the most complete success; and a more severe test than this could not be applied to the pipes anywhere.

Mr. EAYRS: I see that West Bromwich has been mentioned in this paper as having spent some time and money in trying to obtain a legal decision as to the distinction between a sewer and a drain. I am sorry to say that is the case. The Corporation, on putting down the sewerage system, met with a good deal of opposition from the owners of property. Up to the time of the sewers being laid, they drained into ordinary brick channels to the street channels. When the sewers were laid, we called upon the owners to connect their drains with the sewers. We thought they

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ought to have done it, and every one else thought they ought to have done it. The opposition was very strong, and we had a great deal of legal proceedings, which ultimately resulted in a definition of What is a sewer? We had a Local Government Board inquiry; both sides were represented, for and against, and the result is the Local Government Board have given us sanction to borrow upwards of 13,000*l.* to make the connections between the sewers and the boundaries of the private property. The Local Government Board holds that the open street channel is a sewer within the meaning of the Act. Of course it was a revelation to us, but we can see that that is the only logical conclusion to come to under the Public Health Act, and we are carrying it out. With regard to section 23, What was a drain sufficient for effectual drainage? the stipendiary magistrate decided that an open channel drain, where the fall was insufficient to cleanse it, and admitted to be leaky, was sufficient. It is a very melancholy fact to contemplate, but we are compelled to bow to it. With regard to the names of the writers of the letters given in the paper, I am willing for my name to appear as the writer of the fourth letter.

The vote of thanks having been accorded with acclamation,

Mr. J. Parker (Hereford), in reply, said: Mr. President, I must first of all thank you for the hearty manner in which you have received the paper, and proceed at once, at this late hour, to answer the questions which have been put. First, as to pavement and Hall's Ferrumite. We call it Hall's Ferrumite, because we have always purchased it from Hall, and he is the only man we have heard of connected with it. As to asphalte, or tar-paving, being put down at a remarkably low price, I may say that many of our side-walks had a good foundation to begin with. Our plan is to lay on the tar very hot. We always take care to have old tar, in which the ammonia is out of it, and we have very good sand, such as you have seen at the waterworks, and gravel to roll in. We take the cost of the labour and material, and have done it as low as threepence per yard. We have sometimes great inequalities in the surface, and have to go over the work and drop tar into the holes, and that runs up to not more than ninepence per yard. We have a great length of roads, something like 50 miles, to keep in repair, and we have to make a little money go a long way. That it is a very substantial pavement I am not going to contend, but it lasts for many years, and it enables us to cover the paths by the acre. As regards ventilators, my experience is that

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if you have extractors you can do better than without, for as a rule the sluggish gases do not rise, and it is better to draw them out. As to the horse-power of the engines, Mr. Davey will tell you.

Mr. Davey: Maximum 40 horse-power.

Mr. Parker: The area of the filter beds, you, Mr. President, described, and properly described, as being somewhat contracted: but having regard to the fact that it is ground of a most suitable character—it is a natural filter itself, an alluvial deposit of a very porous description, resting on sand and gravel—I think that 6½ acres will be found to be quite sufficient. If not, there is plenty of land that can be obtained to increase the area of the filter bed. With regard to the cement which Mr. Pritchard uses, and which he says was used at the Vyrnwy waterworks, I may say we had not the funds of the Corporation of Liverpool at our backs. We turned our cement over a few times, and tested it by two or three briquette tests, and tensile strain. I do not think I need say anything about the sewers. The Stanford joints I adopted with some reluctance, as the Chairman of the Outfall Committee will bear me out; but the inspector of the Local Government Board suggested the Stanford joint, and the suggestion from an inspector, as you know, very often goes a long way. Luckily for me, each succeeding speaker has answered the previous one. Mr. Lobley answered Mr. Pritchard, and the next speaker answered Mr. Lobley. Mr. Davis agrees with me as to party walls, not only that they are a monstrosity, but that they are unnecessary. That they are useful in London and Liverpool I admit, but they are quite unnecessary in a small town like Hereford. Mr. Davis asked what we were going to do as to growing crops on the farm. I may say we do not intend to grow anything at present, as we think we shall require all the land for filtration. As to the agitators, Mr. Lobley was not answered by the succeeding speakers, and he seems to think we are not agitating so well as he was agitating ten years ago, and that with the great fall we have, agitation is unnecessary. We treat about one-sixth of the sewage, as it leaves the sluice-valve, by the addition of milk of lime, and this saturated solution afterwards rejoins the remaining five-sixths, insuring a thorough admixture of the whole; I therefore contend that that tank answers a very useful purpose. With a small stream of milk of lime going into a great body of sewage extending to 1,200,000 or 1,500,000 gallons a day, there is some chance of the sewage going through

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the tanks without having passed through the lime at all, but we escape that chance altogether by our method.

The PRESIDENT: In the name of the Association, I beg to thank Mr. Scobie, the Chairman of the Outfall Works Committee, for the explanation he made to us at the works, and for his kindness to-day; and the Mayor for the use of the Council Chamber.

Mr. HENRY DAVEY, M.I.C.E., having briefly described the engines—as in Mr. Parker's Paper—proceeded as follows:—

"So far, the engine is an ordinary compound surface-condensing engine. Beyond that, it has that peculiar arrangement which allows of a large amount of expansion of steam. In working steam expansively you get a very great pressure at the beginning, and a very little pressure at the end of the stroke. The resistance of the pump is equal throughout the stroke. Therefore in applying the engine to work the pump, and to make the engine work expansively, you must have some means of equating the pump resistance and the steam pressures. To make one equal to the other in all parts of the stroke, it is necessary to have a larger resistance on the engine at the beginning, and a less resistance at the end. That is effected by the peculiar connection of the engine to the pump. No doubt you are all acquainted with the direct-acting steam pump in which the pump is connected directly to the steam piston. In such pumps it is impossible to get any expansion at all, and there is no economy. The peculiarity of this engine over the ordinary direct-acting steam pump is that the peculiar connection of the engine to the pump causes the pump to impose the same average resistance on the engine, but a great resistance at the beginning, and a small resistance at the end of the stroke. As to the expansion, you can see for yourselves by the index what expansion the engine is working with. The cut-off is one-third of the stroke in the small cylinder, and this cylinder has one-third of the capacity of the other; that gives nine expansions. In the large cylinder the cut off is at one-half of the stroke. The steam is exhausted into a receiver from the small cylinder, and then it passes into the other cylinder. You get by this means as great an expansion as can be obtained by any engine. It is only a matter of arranging the angle at which the steam piston is connected to the pump to get any amount of expansive working."

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After the reading of the paper at the Town Hall, the members, together with the Mayor and Corporation of the City of Hereford, proceeded in brakes to the sewage outfall works, where the newly-constructed works were handed over by Alderman Scobie, Chairman of the Works Committee, to the Mayor. The Mayor turned on the valve of the intercepting sewer, and for the first time the whole of the sewage of the city was received into the works. The members then inspected the buildings and machinery (the engines being fully described by Mr. Davey, M. Inst. C.E.), the filter beds, and resulting effluent. The party next proceeded to the waterworks, where the reservoirs, the pumping engine, a sand-washing turbine, and the water tower were inspected. The members then returned to the Town Hall, where the paper was discussed. After which a visit was paid to the Cathedral, where they were received by the Hon. and Very Rev. the Dean, who escorted the party and explained the many interesting historical monuments.

The members were afterwards sumptuously entertained by the Mayor, at the "Green Dragon" Hotel.

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DISTRICT MEETING AT HAVERHILL.

May 24th, 1890.

Held at the Town Hall.

H. P. BOULNOIS, PRESIDENT, *in the Chair.*

Mr. E. Buckham was unanimously re-elected Honorary Secretary for the Eastern Counties District.

A discussion followed as to whether Saturday was the best day to hold the Meetings of the District. In the result Mr. Buckham undertook to try the feeling of his District in the matter, and report to the Council should it be found desirable to make any change in the existing custom.

The following paper was then read and discussed :—

THE PUBLIC WORKS OF HAVERHILL.

BY J. KEMP, ENGINEER AND SURVEYOR TO THE LOCAL BOARD.

HAVERHILL, or as it stands in old records, "Haverell," or "Haverhull," is a market town of some antiquity, situate partly in Suffolk and Essex, and bordering on the County of Cambridge.

Very little is known of its early history, but it is recorded that in the year 1665 the greater portion of the town was destroyed by fire, including the whole of the houses on both sides of the High Street. There are other matters historical of earlier times, but these are more fitted for the antiquary than for putting before this Association, and, therefore, I will not take up your valuable time, which to-day is limited.

I will, however, with your permission, give a brief sketch of the local government of the district prior to the formation of the Local Board, and thus lead up to the subjects of my paper.

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Prior to 1860 the parish was governed by vestry, the churchwardens, guardians, and surveyor being elected at the Easter meeting. Under this system roads and sanitary matters generally were very much neglected, and in a most deplorable condition; no public improvements were effected during this time, with the exception of gasworks in 1854, by a private company.

About 1860 the management of the roads was taken out of the hands of the vestry and transferred to a Highway Board, which was then formed, having its centre at Wickhambrook, about 11 miles distant.

This Board appointed a professional surveyor for the whole of the parishes included within its district, but the plan worked very badly, and did not meet the requirements of a populous and increasing town like Haverhill.

In 1873 the Risbridge Union Rural Sanitary Authority was constituted, and the management of the town's sanitary affairs remained with this authority until the formation of the Local Board in 1878.

In this year, owing to the increasing population and requirements of the town, and mainly through the exertions of the present chairman, the Local Board was formed, and from this time the town has gradually been improved to an extent which can only be gathered by a knowledge of its condition at that time.

The only drainage consisted of a main sewer over a mile in length, varying from 9 inches to 15 inches in diameter, laid in the Withersfield Road from its junction with the Crowland Road, and thence following the line of the river Stour to the existing outfall, where the sewage was filtered through coke and passed into the river. This sewer was laid in 1868, and the existing High Street and Queen Street sewers connected with it. Those parts of the town known as The Hamlet, Camps Road, The Croft, and Mill Road, probably numbering half the whole population, were without means of drainage into the sewer, but new sewers have since been laid in these districts, and all or nearly all the houses are connected.

The footways existing consisted for the most part of pebbles. A portion on the north-east side of High Street was asphalted, but this being badly laid, soon wore out and became worse than the pebbles. All these footways have been repaved with Staffordshire blue diamond chequered bricks, with cast-iron kerbing and granite sett channelling.

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The roads of the district were also in a very neglected condition, being bad in cross section, and in many cases more like canals than roads. A great length of these roads has been reconstructed and raised a considerable height, the old metal being taken out and used again on the top of the chalk, which is used to take its place, and form a foundation for the new road.

In High Street and Queen Street a great many of the houses were low straw-thatched buildings—one or two still exist; but in the majority of cases these have been replaced by substantial buildings of modern design; a great improvement has also been made in shop window architecture, the small quaint windows having with very few exceptions given place to large modern ones of plate glass.

Having briefly reviewed the condition of the town at the time of the formation of the Local Board, I will now proceed to describe the public works of the district; but before doing so, I will refer shortly to the manufactures, population, &c.

The population according to the last census was 3684, and is now estimated at 4300.

The area of the district is 2447 acres, and the rateable value 8863*l.*; in 1884 the rateable value was 7864*l.*

The principal industry of the town is that carried on by Messrs. D. Gurteen and Sons, at Chauntry Mills, who employ over 3000 hands. This includes ready-made clothing, the weaving of linen and cotton drabbet, towels, strainers, hair cloth, rugs, and mats; it also includes dyeing and finishing. Silk weaving is also carried on to a considerable extent in several factories in the town.

Town Hall.

The Town Hall, where we now are, was opened in 1883, and is the gift of Daniel Gurteen, Sen., Esq., J.P. to the town. The building and site cost about 5000*l.* It is in the Gothic style of architecture, and is built with local red brick and stone dressings from the designs of Mr. G. Sharman, architect, of Wellingborough. The building comprises a large hall, seating 700 people, a lecture-room for small gatherings, reading and recreation-rooms, kitchens, and the usual offices. There is a fine organ in the hall, the gift of D. Gurteen, Jun., Esq., costing about 1000*l.*

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Board Schools.

The Board Schools, situate near the Great Eastern Railway Station, were opened in 1877. The buildings have been enlarged several times since, the total cost being 10,700*l.* Accommodation is provided for about 1000 children. The schools were built from the designs of Mr. F. Whitmore, architect, of Chelmsford, and are reputed to be amongst the finest in the Eastern Counties.

Other public buildings recently erected include a new police station and magistrates' room, situate on "The Pightle," erected in 1886, and a new Corn Exchange erected in 1889, situate opposite the Board Schools.

Infectious Diseases Hospital.

In 1885 the Local Board deemed it expedient to take steps for the provision of a hospital for infectious diseases, and accordingly instructed me to prepare plans and specifications for the same. A piece of land for the site had been purchased some years previously.

A loan of 700*l.* was granted for this purpose after due inquiry by the Local Government Board's Engineering Inspector, and the building was completed in 1886 at a cost of 686*l.* 18*s.* 7*d.*

The hospital is situate on high ground on the west side of the town, and provides accommodation for ten patients in four wards, so that cases of two diseases and of both sexes can be treated at the same time. A caretaker's and nurse's cottage is provided in the centre of the block, and attached thereto; the male wards are administered from the back, and the female wards from the front of the cottage. Behind the main building are the mortuary, disinfecting house, laundry, washhouse, ambulance shed, &c.

The building is of brickwork, built with hollow walls, and covered with slate. Air is admitted to the wards by Tobin's inlet tubes, and on the top of each ward is fixed one of Boyle's exhaust ventilators. Two thousand cubic feet of air space is allowed for each patient.

Gasworks.

In 1884 the Gasworks were purchased by the Local Board at a cost of 2000*l.*, and were under the management of Mr. Corbet Woodall, C.E., until March 26th, 1886, during which time a

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further sum of 2600*l.* was expended on new buildings and plant, including a gas-holder and tank, three new purifiers, retort house, and new mains.

In 1886 I was appointed manager, and up to the present time have designed and erected new buildings, and put down new machinery and plant at a further cost of 2400*l.*, which makes the total capital expenditure on the works 7000*l.*, of which 6150*l.* have been borrowed, and the remainder met out of the revenue.

The new buildings and plant erected and put down under my superintendence include foreman's cottage, office, engine house, coal store, sulphate house, meter and governor house, workshop, 12 horse-power Cornish boiler, 6 horse-power vertical boiler, steam engine and exhauster, station meter and governor, patent retort-charging apparatus, and about a mile of new mains.

When the works were purchased the price of gas was 6*s.* per 1000 cubic feet; at the present time it is 5*s.*, with the prospect of a further reduction shortly.

With the exception of the old holder and purifying shed, the works have been entirely rebuilt and remodelled.

In designing the new engine house provision was made for the engines and compressors for compressing air in connection with the sewage disposal scheme, which I will now describe.

Sewage Disposal Works.

The state of the river Stour, caused by the crude method of dealing with the sewage at the outfall (referred to in the historical sketch in the first part of this paper), at length began to affect the olfactory nerves of the residents along its banks in the adjoining district of the Risbridge Rural Sanitary Authority, by whom, on July 12th, 1880, and subsequently in July 1883, May 1884, and October 1884, complaints were made to the Local Board that the river was polluted by the discharge of unpurified effluent from the sewage filtration tanks, causing a nuisance to residents in the neighbourhood of the river, and destruction of fish and waterfowl.

On May 16th, 1884, the Local Government Board addressed a letter to the Local Board, calling attention to a statement in the Medical Officer's Annual Report as to the pollution of the river; and again on 13th November, 1884, they wrote and enclosed copy of a letter of complaint received from the Risbridge R.S.A., and stating that unless the Board took immediate steps they must

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decline to suspend Sec. 3 of the Rivers Pollution Prevention Act, 1876.

The Board having no alternative, set to work and invited separate schemes from three firms of consulting engineers. The scheme selected proposed to take the sewage by gravitation from a point near the present outfall works to about half a mile further down the valley, and there deal with it on about 15 acres of land adjoining the river near Pope Mill Farm. About half of this land could not possibly have been reached by gravitation. The estimate was 3315*l*. The usual inquiry was held by John Thornhill Harrison, Esq., C.E., on 4th November, 1887, but the application to borrow the money was opposed by several influential gentlemen, who secured the services of Mr. James Mansergh, C.E., of Westminster, with the result that the scheme was rejected.

I was then asked to prepare a scheme, and after visiting several places with Dr. William Armistead, Medical Officer of Health, including Warrington, Colchester, Buxton, Luton, and the Houses of Parliament, we recommended the Board to adopt a process of land treatment, and for that purpose to purchase 8½ acres of land adjoining the existing outfall works, and lying in the angle formed by the junction of the Colne Valley Railway with the Cambridge, Haverhill, and Sudbury branch of the Great Eastern Railway, the highest point of which land is about 30 feet above the invert of the outfall sewer. We also recommended the Board to adopt compressed air and Shone's ejectors for lifting the sewage, because the compressing plant could be put down at the Gasworks and worked and managed by the foreman, thus saving the expense of a separate station and management. The total cost I estimated at 2250*l*. Application was made to the Local Government Board to borrow this amount, which was granted after due inquiry into the matter by J. Thornhill Harrison, Esq., C.E., on the 14th August, 1888, who commended our choice, both as to site of land and motive power.

The land is triangular in shape, and is bounded on the south side by the Stour and Couples Road, on the west by the Colne Valley Railway, and on the north and east by the Cambridge, Haverhill, and Sudbury branch of the Great Eastern Railway. It slopes gently towards the river and Couples Road; a portion, about 1½ acres adjoining the river, is flat.

The soil for the greater part consists of a good staple at depths varying from 12 inches on the higher ground to about 5 feet at the

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bottom of the slope, where the chalk bed descends abruptly and is not found on the flat portion at 18 feet from the surface, the depth excavated for the ejector chamber. This part of the field has evidently been the original bed of a river of much larger proportions than the present one, judging from the nature of the soil, which consists of alluvial deposits of loam, sand, gravel, and, at a good depth from the surface, of clay.

This portion of the field is prepared for "intermittent downward filtration," and was trenched 4 feet deep, and the gravelly and lighter portions of the soil mixed with the heavier; it was also raised some 2 feet in height by soil from the upper part of the field; it is drained from 5½ to 6 feet deep with 4-inch drains, 5 yards apart, running into a 6-inch main, the outlet of which is into the river opposite the eastern extremity of the farm.

The upper or "broad irrigation" portion of the farm is simply land-drained with 3-inch pipes 5 yards apart, and from 2½ feet to 3 feet deep, into a 5-inch main, connected with four dry-bricked dead wells, 10 feet deep by 6 feet diameter, which receive the effluent; the last well is provided with an overflow communicating with the main drain on the lower level, so that should the wells at any time fill, the surplus effluent will pass away by the overflow. From experiments tried in a chalk-pit in the upper part of the field, I found that from 8000 to 10,000 gallons of sewage were absorbed in 24 hours, and in this case the sewage had not previously undergone filtration through the soil.

The sewage is distributed from two tanks, into which it is lifted by the compressed air; the low-level tank is 24 feet 6 inches above the discharge level of the ejectors, and the high-level 38 feet 9 inches.

These tanks are excavated out of the ground and banked up with earth; each is provided with two ordinary slide valves at different levels, one for liquid outlet and the other for sludge; they will each hold about 20,000 gallons. 12,000 gallons are ejected at intervals to these tanks according to the time taken to fill the storage tank at the ejector station. The sludge is allowed to settle, and then the liquid is slowly distributed over the land by means of ordinary disc valves. The sludge is run off at a lower level into a sludge-pit at intervals of two or three weeks and readily carted away by a farmer.

The compressing plant is at the gasworks, and consists of a pair of coupled horizontal high-pressure non-condensing air-com-

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pressing engines, each with one steam cylinder 6 inches diameter and one air cylinder 9 inches diameter, the stroke of each being 12 inches. The engines are to be worked separately or in conjunction; one air cylinder, therefore, can be disconnected when it is desired to compress the air to a higher pressure.

An air receiver is also provided connected with the air main; this consists of an egg-ended boiler 29 feet long and 4 feet 6 inches in diameter.

The air main is laid from the gasworks to the ejector station at the outfall, a distance of 2040 yards; it consists of 3-inch open-socket cast-iron pipes laid in the main road and jointed with yarn and lead, two-thirds of the joint being lead. The joints were tested up to 40 lbs. to the square inch when laid; a gauge was placed at each end of the main and the air within it compressed to 40 lbs.; the valve next the compressors was then shut off for 20 minutes, when, if no loss of pressure was apparent, the joints were deemed satisfactory.

Two of Shone's 150 gallon ejectors are fixed in the ejector chamber, which is built rectangular in 18-inch brickwork in cement, being backed up with concrete and rendered with 1-inch Portland cement mortar 1 to 1. The chamber is 11 feet by 10 feet by 13 feet 6 inches deep, and the ejectors are fixed sufficiently deep to drain the old tanks which are now used as storage tanks for the night flow, or for any other time when it is not deemed expedient to keep the compressors constantly at work. At present the sewage is stored until the tank is full (12,000 gallons); by this arrangement the whole of a day's sewage, about 24,000 gallons, is ejected in two hours to either lift.

The rising main is 6 inches in diameter and to the first lift is 400 feet long; to the higher lift, 800 feet. It consists of cast-iron open-socket pipes, jointed similarly to the air main.

The plant is capable of raising 180,000 gallons of sewage per day of 12 hours, to the 24 feet 6 inch lift, or 144,000 gallons to the 38 feet 9 inches lift.

The dry weather flow of sewage for 24 hours is 24,000 gallons; in wet weather it is nearly double that quantity.

In actual working, by repeated tests, I have found that with 7·35 H.P., 200 gallons of sewage per minute can be raised to the higher lift, the air being compressed to 22 lbs.; with 7·31 H.P., 250 gallons per minute can be raised to the lower lift with the air compressed to 15 lbs.

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I have not been able to ascertain as yet the exact coal consumption per horse-power per hour, as steam is supplied by the same boilers for other purposes.

The entire cost of the works was as follows:—

	£	s.	d.
Air-compressing plant, ejectors, and fitting	602	19	6
Ejector chamber and manhole	139	10	0
Air main (2040 yards)	338	1	2
Rising main (270 yards)	76	18	5
Preparation of land, including draining, trenching, tanks, raising, and road-making	375	5	7
Fittings, valves, stop-gates, &c.	41	12	1
Alterations to old storage tank	20	2	0
Purchase of land	591	3	1
Engineering—legal expenses	128	12	4
Incidental and sundry expenses	20	0	0
Total	2334	4	2

The estimate was 2250*l*.

As the works have only been working some four months, I am unable to give you anything like a profit and loss account. I may, however, mention that the sewage farm committee have agreed to pay the gas department the sum of 30*s*. per week, for supplying steam, attending to engines, supplying oil, &c., and for rent of engine house.

The whole of the works are carried out without any attempt at show or architectural embellishment, in as simple a manner as possible, but are, we consider, sufficient for a small country town and for the purpose required.

Figure 1 gives a sectional view of a Shone Pneumatic Ejector of ordinary construction, suitable for raising water, sewage, sludge, or pail contents.

The motive power employed is compressed air, and the action of the apparatus is as follows:—

The sewage gravitates from the sewer through the inlet pipe A into the ejector, and gradually rises therein until it reaches the under side of the bell D. The air at atmospheric pressure inside this bell is then enclosed, and the sewage, continuing to rise outside and above the rim of the bell, compresses the inclosed air sufficiently to lift the bell, spindle, &c., connected therewith, some 1½ inch, which opens the compressed air admission valve at E. This movement has carried over the slide valve of the automatic gearing (shown in detail in Figs. 2 and 3), so as to permit compressed air to act upon the main valve V^3. The latter is driven over to the position shown

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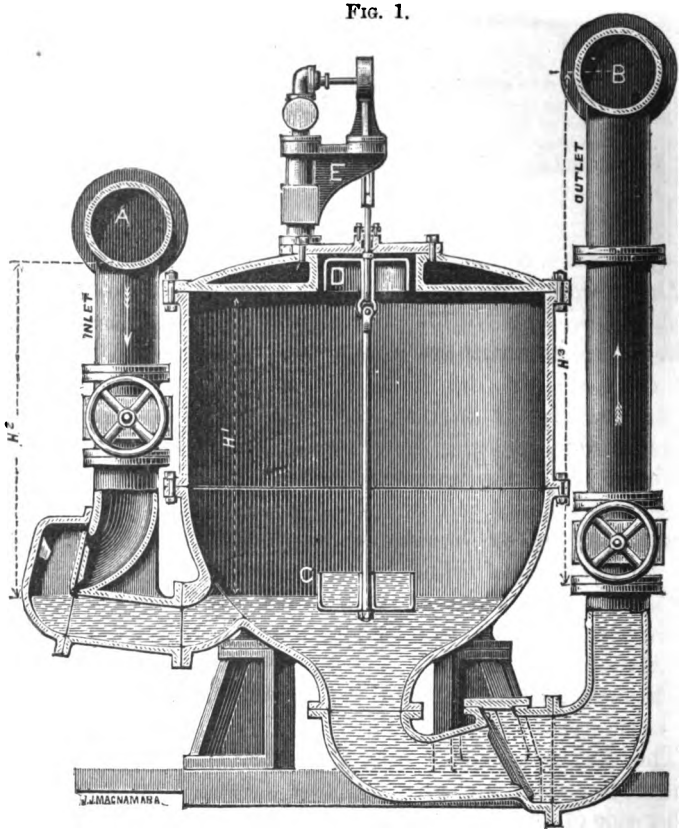
by Fig. 2. The compressed air then passes through the ports of the main valve, on to the surface of the sewage in the ejector, and the sewage being prevented from returning into the sewers, by the inlet valve F falling on to its seat, is forced through the delivery valve G, into and along the sewage rising main B or high level gravitating sewer, as the case may be. The sewage passes out of

FIG. 1.



the ejector, until its level therein reaches the cup C, and still continuing to lower, leaves the cup full until the weight of the liquid in the portion of the cup thus exposed and unsupported by the surrounding water, is sufficient to pull down the bell and spindle, &c., connected therewith, thus reversing the action of the slide valve, and admitting compressed air to act on the opposite end of the main

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FIG. 2.

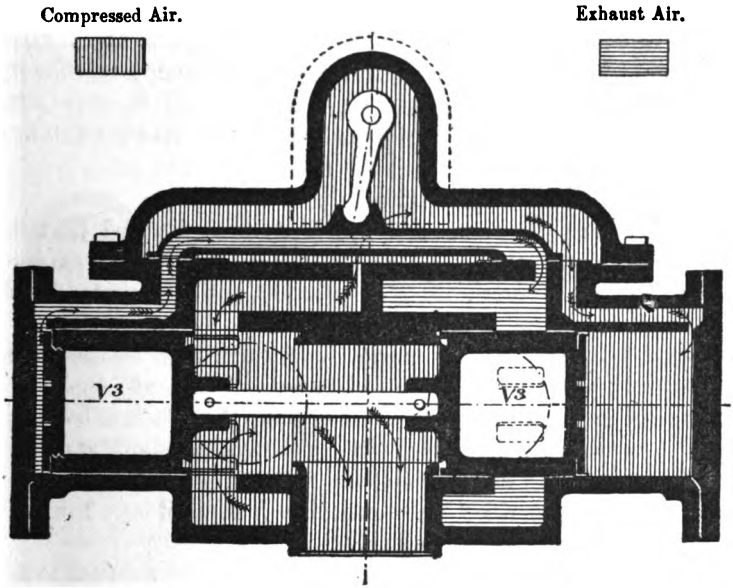
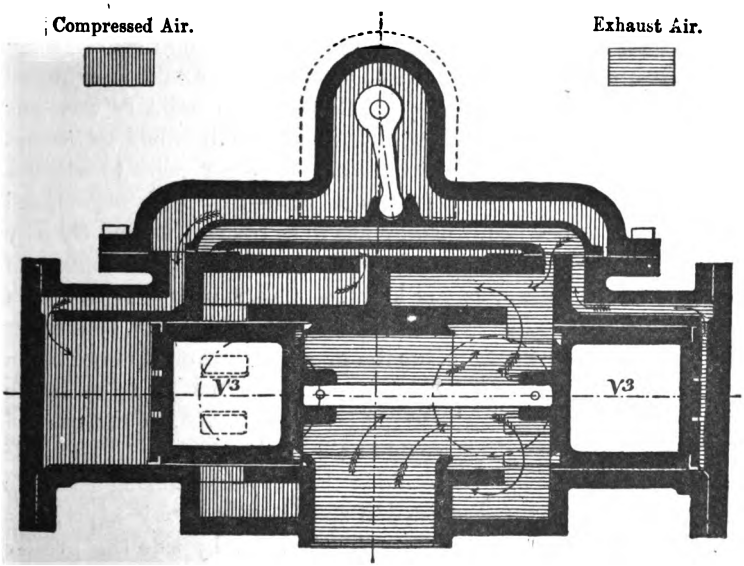


FIG. 3.



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valve V^3, driving it over to the position shown in Fig. 3. This first cuts off the supply of compressed air to the ejector, and then allows the air within the ejector to exhaust down to atmospheric pressure. The outlet valve then falls on to its seat, retaining the liquid in the sewage rising main; the sewage then flows into the ejector through the inlet once more, driving the free air before it through the air valve as the sewage rises, and so the action goes on as long as there is sewage to flow.

The position of the cup and bell floats is so adjusted that the compressed air is not allowed to exhaust until the ejector is emptied down to discharge level, nor is it admitted until the ejector is full of sewage.

I ought to state that this scheme is not carried out on the Shone system in its entirety; but that, at present, it is merely applied to lifting sewage at the outfall. In designing the scheme, however, I did not overlook the fact that one day the system might, at a small additional cost for new ejectors and stations, be extended to the main outfall sewer, which has at present a gradient of only 1 in 680, and is therefore not self-cleansing.

Connections to as many new stations as might be required to lay the sewer in sections at self-cleansing gradients could be made with the existing main, and the compressed air could be supplied by the same machinery to lift the sewage from the low to the high level sections of the sewer at these several stations, and in this manner the gradients could be obtained without coming into contact with the subsoil water. To give you an idea of what would be required to secure such a gradient, say 1 in 200, in the ordinary way, our main sewer (2000 yards in length) at the outfall would be 36 feet deep, and nearly 30 feet under water. Another point to which I should like to call your attention is this—that with our outfall sewer as at present laid, flushing has to be resorted to, and thereby a large quantity of additional water is added to the volume of sewage; this, of itself, as you know, is a very serious matter with any sewage-farm. The same thing would also happen with a sewer laid in the subsoil water, unless the greatest precautions were taken to ensure its being water-tight; but with ejectors placed as before mentioned these drawbacks would be obviated, and, in the case of flushing, the sewage itself would be the flushing agent. The whole of our branch sewers are, or could be, laid at self-cleansing gradients in the ordinary way. I omitted to state earlier in my paper, that the air main and the main sewer are laid side by side the greater

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part of their length, the compressing station being at the head of the sewer.

I hope the members who are present to-day will not go away disappointed at viewing works on so small a scale; indeed, I should not have ventured to invite you, had not our esteemed District Secretary expressed a strong wish to hold a meeting here; nevertheless, I am very pleased indeed to have the honour of your visit.

DISCUSSION.

The PRESIDENT: In opening this discussion, I have the very greatest pleasure in proposing a vote of thanks to Mr. Kemp for his paper and lucid explanation of the works we have seen to-day. With regard to the last remark of Mr. Kemp in his paper, apologising for showing works on so small a scale, all I can say for members of this Association is, that works of this size are extremely valuable to some of us. Of course some of our members represent towns of considerable size, but there are other members among us who are surveyors of small towns, and any information in the way of what small towns have been able to do in dealing with sewage is of extreme value. Mr. Kemp has shown to-day that he is a very valuable officer of the Board he represents. There are one or two points in regard to the paper which I should like to discuss. The first question is as to the footways being paved with Staffordshire bricks. This being an inland town, and a long way from Staffordshire, I should like to know the cost. Then as regards the metalling of the roads, I conclude they are metalled with flints. I should like to ask if there are any bye-laws in force in Haverhill with reference to buildings. I must confess I was struck, as I walked from the railway station, with the appearance of the board schools. We have not had an opportunity of going over those schools, but it was evident from the external appearance they are equal to anything of the kind we have seen. There is one word about which I should like explanation, that is the reference to the new police station on "The Pightle."

Mr. GURTEEN: That is the name of a street.

The PRESIDENT: Has it any historical association?

Mr. GURTEEN: It means a piece of enclosed land.

The PRESIDENT: It is an old Suffolk term. It is an interesting word which is quite new to me. Passing on to the sewage disposal

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works—the works we have seen are admirably adapted for the purposes for which they are intended, and the land is evidently suitable for the purpose of irrigation. Mr. Kemp has told us what the formation of the land is, and how it has been treated. He mentions that the land drains have been placed five yards apart, that seems to me rather close together. I am sorry the members did not see the effluent water coming from the farm or the filter bed. I should like to know whether any analysis has been taken of the effluent, and whether it complies with the requirements of the Rivers Pollution Act. The whole of the land is about 8½ acres, which with a population of 3684, comes to about 412 per acre. That is a very reasonable amount. I think you will find in Professor Robinson's book on Sewage Disposal, that on land of a suitable character the sewage of as many as a thousand persons per acre can be treated and the land will not get sewage-sick. Here the whole of the sewage has been put on 1½ acre, growing osiers, flax, and carrots. That amounts to the sewage of 2300 persons per acre. We are also told that the water supply has to be obtained from wells, and that the supply per head of the population is only eight gallons. Taking the water supply of an ordinary town at sixteen gallons per head per day of the population, that would give the sewage of 1150 persons per acre treated on this land. That is rather excessive, and it will be interesting to watch whether that filter is able to deal properly with the sewage of this district for any length of time. The sludge, we are told, is carted away by a farmer. Mr. Kemp did not tell us whether he pays for that advantage, or finds any value in it as a manure. With regard to the system generally—the Shone system of ejectors—which I think has been most wisely adopted for the town, the power is obtained from the gasworks, and this is what Mr. Shone obtains from his invention, a transmission of power in the best possible manner. Of course pumping works could be erected at the outfall, and supposing no works existed where power could be obtained, it might be better and cheaper to supply them at the works, but in this case, where the power is ready, my own opinion is that Haverhill has done wisely in adopting the Shone system. With regard to the transmission of power by air, it has always been a disputed point as to its efficiency. The loss by the system of compressed air in the Mont Cenis tunnel was 3½ per cent. by friction, and 5½ per cent. by escape. I don't know whether it is possible at these works to make any experiments of the kind, but

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if Mr. Kemp could do so, it would be interesting to all of us. There is one other point upon which I can congratulate Mr. Kemp —that is, his estimating. His estimate for these sewage outfall works was 2250*l.*, and he carried them out for 2334*l.* 4*s.* 2*d.* We all know what that means. It means care in the execution, and I congratulate him very highly upon what he has done. Again, his scheme was carried out at a cost of nearly 1000*l.* less than the other scheme we have heard of, which was not adopted, and would not have answered if adopted, as part of the land was at too high a level, and gravitation would not have carried all the sewage there.

Mr. GODFREY: I beg to second the proposition of thanks to Mr. Kemp for his paper, and I do so with the more pleasure as on my coming into this room, Mr. Kemp was the first gentleman to shake me by the hand, and to remind me that we had worked together some eleven years ago. He was quite young then, and I was pleased to find him here, and to see the good work he has done. Having read his paper, and followed your criticism, Sir, I most cordially endorse your remark that Haverhill is to be congratulated on having so excellent an officer. I wish every member of the Association could carry out his work so near his estimate as Mr. Kemp has done. I am sorry to say I cannot always do so. There are very many of us, who come from small towns, who have occasion to thank you for coming to a small place like Haverhill, and showing us what you have been able to do here with the disposal of your sewage. Our object, and our duty in most instances, is to spend as little as we can, and spend that little as well as we can, as we have not a large rateable value to deal with. I should like to ask Mr. Kemp where he gets his iron kerbing from, and what it costs. That is a new idea to me, and it seems to be a good one. With regard to the carriage of the sewage, a population of 412 to an acre seems to be a very reasonable and workable proportion. At Kendal they have something like 1300 persons per acre on the intermittent downward filtration system. There they have to dig their trenches every six months or so.

Mr. EACHUS: I have very much pleasure in supporting the observations which have been made with reference to Mr. Kemp's paper. I am sure we have all been very pleased, and I must say, personally, not having been acquainted with the advance Haverhill has made, I am particularly pleased in finding the advance in it since I last heard of it at Saffron Walden twenty-five years ago.

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As to the works connected with the Local Board, they are small, but they are efficient. We have had a treat also in seeing some works which are not among the smallest of their kind. It has been a matter of great interest to me to go over those works, and I am sure it has been the same to every member of the Association who has had the privilege of being here to-day. There is another point which strikes me as one upon which the Board and their officers are to be congratulated—that is, the economy all through with which their works have been carried out. Their Town Hall has cost them nothing, but is a gift to the town by Mr. Gurteen; the Board Schools have cost a larger amount. I quite agree with the President that they are models of the kind. The Infectious Diseases Hospital, with accommodation for ten patients, cost 700*l.*, which is at the rate of 70*l.* per bed. The average of most places is 200*l.* or 300*l.* a bed. That is very economical, and at the same time, being divided into four wards, for two diseases, and for both sexes, seems to have been very efficiently done. With regard to the gasworks, I think the Board have been wise in possessing themselves of these works. The consumption has largely increased since the purchase of the gasworks, and being continuous, those works must in course of time become a very remunerative investment. Then we come to the sewage disposal works. I must confess I went down to look at the brook where the effluent is supposed to be found and I did not see any effluent, and having read the paper I suppose it is doubtful whether there is any effluent to be found there at all, especially as there are such good safety valves in the chalk pits. From the paper I gather that from 8000 to 10,000 gallons of sewage are absorbed there in twenty-four hours. I do not suppose Mr. Kemp has been able to find it afterwards; if it is visible, perhaps he will be able to tell us where it goes. With regard to sludge, I think Mr. Kemp is fortunate in getting a farmer to clear it away free of cost to the Board. Many of us who have had accumulations of sludge, have found it a source of inconvenience. It formerly accumulated at my own place at Edmonton, near London. We have been obliged to take more land, and instead of allowing the sludge to accumulate upon the land, we run it upon any portion of the land which is fallow, and capable of receiving it: let it lie there, and then plough it in, and we see no more of it. By that means we have got rid of all the cost of carting the sludge away, and we do not see any dirty sludge lying about the place. With regard to the Shone

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system, I think the system here is a very good one. For less than 500*l.*—the cost for the air main was 338*l.*—the power is sent from the gasworks to the sewage farm, and putting that at 5 per cent., a cost of 25*l.* a year, you save the expense of a man, which you must have had if you had had an engine at the works. I have only had one similar district to deal with, and that is Mablethorpe, in Lincolnshire, and the cost there was 50*l.* a year to get a man to look after the pulsometer. That represents 1000*l.* Instead of finding 50*l.* a year and fuel, you can do the work for 25*l.*, which is a matter of considerable economy in a small district. My visit here has been a very pleasant one, and I congratulate those who have come, and the Local Board and Mr. Kemp, for the way in which the work has been done.

Mr. Silcock: I wish to say a word or two in support of the proposition. I can personally testify to the improvement of Haverhill in its general appearance, for I happened to be round here seven or eight years ago. The train service is, as some gentlemen are aware, rather peculiar, and I had to wait here two or three hours; so I walked round the town and looked at it, and I can endorse the remark of the chairman as to the great improvement which has since taken place. I should like to ask Mr. Kemp whether or not he considered the question of putting down a gas engine to pump the sewage. It appears to me that a gas engine and pumps might have been provided for the 600*l.* put down as the cost of ejectors. A 7 horse-power is being used to pump 200 gallons of sewage per minute, when a 2 horse-power gas engine would do the work. A gas main would not cost quite as much as the air main, and I should like to know whether he went into the estimates of putting down a gas engine and ordinary pumps in place of Shone's ejectors. It is claimed that the use of ejectors does away with a separate establishment. But there were two men on the farm to-day, and I presume there is always one there, and it does not take much skilled labour to run a gas engine. I can quote an instance where a woman has run a gas engine for years, and a man has merely to look after it occasionally. Probably you would be able to find a man capable of running the gas engine for 10*s.* a week more than the wages of the man you have there, and as a set-off against this expense, the 12*s.* a week paid to the gas company for the use of engine, &c. would be saved. Then, in place of the 7 horse-power engine you have now to provide, you would have to provide only a 2 horse-power gas engine. There is

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another thing I should like to ask; as to whether there has been any trace of contamination by sewage of any of the wells in the district. I understand here you have no water supply, and that the whole of the water is drawn from wells. The sewage works are situate at the lower part of the town, and the wells are probably all above the level of the sewage works; still, I should like to know whether there is any trace of contamination.

Mr. Marks: Like most of the speakers, I wish to thank Mr. Kemp for his paper, and for the works we have seen to-day. I am a long way from the important place which I represent, but I shall go back a wiser, a more enlightened, and a more light-hearted man, because I find that even in a place like this there is a great deal we can learn. I do not think there is any need for the apologetic paragraph in Mr. Kemp's paper; on the contrary, I think we have all been delighted by our visit here. I should like to say a word as to some of the advantages of Local Boards possessing their own gas and waterworks. At Llandudno the gas and waterworks were transferred to the Local Board in 1876, and we have spent there 60,000*l.* in constructing new gas and waterworks, purchase of land, and payments to the old companies. We have been able, in 13 years, to relieve consumers and the town to the extent of something like 10,000*l.* When we took over the gasworks the old company were charging 6*s.* 6*d.* per thousand for gas, and we have by gradual reduction, by efficiency in working, and by enterprising efforts, been able to reduce the price to 4*s.* 6*d.*, with the prospect of reducing it at the next meeting another 3*d.* per thousand feet. These successive reductions in price have gone into the pockets of the ratepayers. I am very glad to hear you are thinking of obtaining waterworks, for if you obtain these works you will be on the point of perfection. The very fact that you have had the gasworks in your possession, has enabled you to have steam power at a very low price indeed. Mr. Kemp has said he has made no pretensions to architectural embellishment. He will pardon me if I differ from him. I was particularly struck with the very neat way in which the engine room is fitted up. There is a 5-feet dado of glazed tiles, with another border of 6 inches very ornamental. Whatever may have been the first cost of that work, you will feel the benefit in not having anything to harbour dust or dirt. My Board, contrary to the ways of Boards in general, have very generously offered to pay my expenses here to-day. I do not think that it is a usual thing, but I hope other

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Local Boards will be induced to do the same. The information I have gained here will be of greater value to my Board than the few pounds my visit will cost; and [addressing the Chairman of the Local Board] I give you, Sir, a respectful but broad hint—whenever there are any district or annual meetings of this Association, send your Surveyor to those meetings with a good round sum in his pockets, and tell him to bring back all the information he can.

Mr. BUCKHAM: Of course you are aware that all engineers, in arranging schemes of drainage, do as far as they can endeavour to get their sewers all to gravitate to one point of outlet. It seems to me this Shone system comes in and takes an intermediate position, and helps engineers to carry out drainage works where they have to resort to pumping. And in this way: in Haverhill, you have a duplicate ejector that is almost like a pump; where the nature of the ground is such that it is difficult to get an outfall by gravitation without considerable expense, Shone's ejectors come in and raise the sewage eight or ten feet at a time, so that by a series of small lifts these Shone's ejectors enable the sewage of a tidal town to be discharged at high water. For instance, if you were to construct your sewers to be self-cleansing, you might be landed under low water. It appears to me this invention is a very valuable one; by making the lifts at various points, worked by power at a considerable distance off, the expense of deep sewerage in the drainage of a town is avoided. In reference to this, it may be in the memory of many members that, some time in 1888, there was an article in *Iron* on the proposed drainage of Margate, suggesting that, before the Corporation of that town decided upon any plan, Shone's system should have their careful consideration. Mr. Baldwin Latham was concerned for the Corporation, and he condemned it as being a very bad application, and a very expensive way of raising sewage. Mr. Latham advocated, as against Shone's system, pumping by water; or the hydraulic against the pneumatic system. I am bound to say, in my judgment, the application of air for raising sewage is in every way better than water. I believe that water is something like 200 times heavier than air, and if I am right in saying the friction of any element is in proportion to its density, air, where it is worked at a moderate pressure, must be better than water. The only thing I don't seem to find out with regard to Shone's process, or the hydraulic process of pumping, is the cost. We are not helped

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much in the consideration of this matter of cost by any information given in the paper. I think there is a place near London—Friern Barnet—where the hydraulic process is applied, and even there I have not been able to find the cost of working. There is one thing with regard to the application here. According to Mr. Kemp's figures of the cost of the works here, it seems to me that supposing Shone's process had to be applied to a town of a population of 25,000, the cost to the town would be 26,744*l.*, half this sum being for the Shone plant, and the other half for laying the sewers proper. Well, sir, if the sewers of a town of 25,000 inhabitants can be laid at a cost of a little over 1*l.* a head, I think that is a very reasonable amount for sewerage works. In conclusion, Mr. Buckham announced letters of regret from the Borough Engineers of Norwich, Yarmouth, and Bury St. Edmunds, and Dr Elliston, medical officer of Ipswich.

Dr. ARMISTEAD: I should like to say a few words with regard to the effluent. I am sorry you did not see it. I have seen it as clear as the water in that decanter. Any one who remembers the river before this system was carried out, will know that in the summer months the only river was the foul effluent from the old sewage works. I think any one going to the river now, would find it difficult to detect any difference in the river above and the river below the outfall, and I am sure he could not find any difference as to colour. We have not had any analysis made of the effluent, but I believe it comes up to the standard required. With regard to Shone's system, any one who wants to see it at work should go to Warrington, where they will be able to see it in perfection. As regards the pollution of the wells, I cannot say anything in favour of the wells of Haverhill. They were polluted long before the sewage works were made; but I can say they have received no pollution from the sewage works. We hope to have waterworks soon, and as we shall have those works considerably above the town, there will be no possibility of sewage flowing upwards to our well.

Mr. MANN: Before my appointment as surveyor, the town I represent had been sewered at a cost of thousands of pounds, the repayments being spread over a period of thirty years, and in addition we pay about 240*l.* per annum for the privilege of discharging our sewage into the system of an adjoining authority. I can say Haverhill stands in a very advantageous position as to cost of sewerage works, compared with the town I represent.

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The vote of thanks to Mr. Kemp for his paper having been adopted by acclamation,

Mr. KEMP, in reply, said: In the first place I will reply to the questions put by the President of the Association. With respect to sewage sludge, we get no pay for it; we are very glad to get rid of it. We have had no analysis taken of the effluent yet, and the reason it was not seen to-day was, that the sewage from the tanks had not begun to flow on to the beds. We allow it to remain in the tanks for the sludge to settle, and then let it flow off gradually. With regard to the brick pavement, it cost us 4*s.* 6*d.* per square yard, and the kerbing cost 3*s.*, and with a granite set channelling, another 2*s.* 6*d.* per yard. With regard to the metalling of the roads, we use Mount Sorrel granite, and I believe it is the intention of the Board to use granite on all the roads when they have reached the proper level. The cost of granite here is 11*s.* per ton. With regard to bye-laws, I may say the bye-laws in force are the Model Bye-laws of the Local Government Board.

A member asked the depth of the kerb.

Mr. KEMP: Ten inches. It is supplied from Wellingborough, by Messrs. Williamson & Co. As regards experiments as to the friction of air in the air mains, we have had no opportunity of doing it yet, but I intend to learn as much as possible of it, and I shall be glad to report the results to a future meeting of the Association. As to the contamination of wells by the sewage, there is no fear of it, as the flow of water is in a different direction. Replying to Mr. Silcock, I may say we did consider the question of a gas engine, but at the price of gas here it would have cost us 25*s.* or 30*s.* a week. With regard to pumps, I do not think you would get any pumps to lift what we lift with the ejector. I do not think a little outlay is lost in keeping works clean.

The members inspected the extensive clothing manufactories of Messrs. Gurteen. These works, which employ about 3000 *persons, are admirably adapted for the purposes of the trade, and the convenience and comfort of the workpeople are carefully studied by the firm. The sewage works and gasworks were also inspected with interest, the authorities having carried out works of the most complete kind for the requirements of the town, at a comparatively small cost. In the afternoon the members of the Association were entertained to luncheon by Mr. Gurteen, Jun., at the Town Hall.*

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DISTRICT MEETING AT BURNLEY.

May 31st, 1890.

Held at the Town Hall, Burnley.

H. P. Boulnois, President, *in the Chair.*

The members assembled in the Council Chamber in the Town Hall, where they were received and warmly welcomed by the Mayor of Burnley (Thomas Thornber, Esq., J.P.), who gave a brief sketch of the works of interest to be visited.

The President, on behalf of the Association, thanked the Mayor for his welcome, and, in alluding to the value and importance of the Association, pointed out the desirability of Corporations paying the expenses of their surveyors in attending the meetings.

Mr. S. S. Platt, of Rochdale, was unanimously re-elected Honorary Secretary for the Lancashire and Cheshire District.

SEWAGE DISPOSAL AND OTHER WORKS AT BURNLEY.

By F. S. BUTTON, Assoc. M. Inst. C.E., Borough Surveyor, Burnley.

The last district meeting at Burnley was held on the 25th April, 1885, when it was stated, in a paper "On the various works in connection with the Borough of Burnley," by Mr. Stafford, Assoc. M. Inst. C.E., the then Borough Surveyor,* that the population was 68,500.

Burnley, like all large Lancashire towns, is a striking example of the progress of the country during the present century.

* See 'Proceedings Assoc. M. & S. E. & S.,' vol. xi. p. 135.

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The population

in 1801 was	3,918	in 1851 was	20,828
1811	5,405	1861	28,700
1821	8,242	1871	40,858
1831	10,026	1881	58,882
1841	14,228	1889 about	83,000

and at the present time it is estimated at 93,000.

In 1871 an extension of the borough boundary was obtained, the area being thereby increased from 1131 acres to 1731 acres, and a further extension was obtained last year; the area now being 4015 acres. Under the Local Government Act of 1888, Burnley became a county borough on April 1st, 1889. The outcome of this extraordinary growth is—large and important municipal works, and herewith are appended descriptions of those which it is proposed the members of the Association shall visit.

Town Hall and Public Baths.

This structure includes the municipal buildings proper, the Magisterial and Police department, and the public baths. The foundation stone for the Town Hall was laid by Mr. Alderman Baron, the then Mayor, on the 24th October, 1885; and the foundation stone for baths was laid by Mr. Alderman Keighley, Chairman of the Health Committee on the same day. The baths were opened to the public on July 7th, 1887, and are greatly appreciated. The Town Hall was opened on October 27th, 1888. The principal or front elevation faces Manchester Road, and is three stories high above the level of the street. The length of the frontage is 115 feet by an average depth of about 130 feet, the general elevation being about 60 feet in height.

The building, which is Italian Classic in style, is surmounted by a clock tower rising to a height of 90 feet above the ground level. The original design for the Town Hall showed a clock tower having a total height of 125 feet, but when the works were let, it was not considered advisable to build it, and consequently no provision was made in the shape of foundations. Some considerable time after the commencement of the works, however, it was decided to erect a clock tower, and had the foundations been sufficient no doubt the original design would have been carried out; but the architect, not feeling justified in adding this additional

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weight to the structure without proper provision, the tower was curtailed to its present proportions. The whole of the stone in the front and returns is cleansed ashlar from the Oakworth Quarries, Yorkshire, and all the remaining elevations, including those of the baths, are in Yorkshire parpoints. The building contains a handsome council chamber and a suite of apartments for the Mayor, with committee rooms, offices for Town Clerk, Borough Surveyor, Borough Accountant, School Board, Sanitary Inspector, Magistrates' Clerk, and Chief Constable and Police department, two Police Courts, cells, kitchens, and mortuary.

The baths face Bath Street, and have a frontage of 147 feet by an average depth of 70 feet. The building contains two plunge baths, 72 feet by 37 feet and 62 feet by 30 feet respectively, twenty-six slipper baths, six vapour baths, manager's apartments, boiler-room, coke store, steam laundry, drying room, &c.

The total cost of the block of buildings, including furnishing, was a little over 50,000*l*. The architects were Messrs. Holtom and Fox, of Dewsbury.

River Pitching.

There are two streams (the Calder and the Brun), which flow through Burnley. Both these streams rise in the Pennine Range on the Yorkshire border, about four miles east of Burnley, and unite about 500 yards to the north-west of the Town Hall, passing along under the name of the Calder to the Ribble. The beds of both these streams average 30 feet in width, and are pitched or paved for nearly the full length of their course through the built-up portion of the town. This work was commenced in June 1873, and has been carried on at intervals since that time. The thickness of the pitching used is 12 inches; it is laid in courses, the joints being well racked up with shingle, and afterwards grouted with cement. In the middle of the stream is formed an invert 6 feet wide and 1 foot 6 inches deep for the dry weather flow. The pitching on each side of the channel is strengthened by means of cross timbers 18 inches by 9 inches, laid from the river walls to the side of the invert, and which are bolted down to 9-inch by 6-inch iron-shod piles 6 feet in length. These cross timbers are of pitch pine, and are laid at regular distances of 25 feet, and cost 55*s*. per set fixed complete. The average cost of paving the river bed is about 12*s*. per square yard exclusive of cost of cross timbers.

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Daneshouse Storeyard.

This yard, which is now nearly completed, covers an area of 2½ acres. It is conveniently situated, having the Leeds and Liverpool Canal on one side and the Lancashire and Yorkshire Railway on the other, with which latter it has communication by sidings. The yard contains storekeeper's house, offices, store-rooms, stables, workshops, engine and boiler-house, wharves, &c., and when completed is expected to cost about 9000*l.*, exclusive of land, which is held under a perpetual ground rent.

The works yet to be completed are, masons' sheds and cart sheds, and the east boundary walls. A new steel boiler, 30 feet by 7 feet 6 inches, is being made for supplying steam to a 12 horse-power engine which will shortly be fixed to drive a 15-inch by 10-inch stone-breaker, and mortar mill, &c. A steam pillar crane with a 35-foot radius, to lift three tons, will also be erected, to unload materials from the canal.

Sewage Disposal Works (Past).

In 1871 the main outfall and main intercepting sewers were begun in earnest, and their construction occupied several years. Up to 1876 the question of sewage disposal occupied attention, and Mr. W. B. Bryan, M. Inst. C.E., the then Borough Surveyor, reported upon the subject, the outcome of which report was the design and construction of the Duckpits Sewage Works arranged to suit the application of General Scott's process of sewage purification and utilisation.

An agreement was entered into in 1878 with Scott's Sewage Company, Limited, wherein the company undertook to treat the sewage for a period of twelve years, receiving the sum of 1050*l.* for the first year (6*d.* per head on a population of 42,000), the said sum of 1050*l.* to be increased annually by 20*l.*

In 1886, however, the Corporation having received so many complaints, met the representatives of the company, and agreed with them to cancel the unexpired portion of the term of the agreement. The company's plant was valued by Mr. Stafford, Assoc. M. Inst. C.E., then Borough Surveyor, at 1055*l.* The Corporation paid over this sum to the company, and forthwith entered into possession of the works. The Corporation, therefore, have only had sole control of the Duckpits Sewage Works since the latter part of 1886.

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The following is a description of the works, prepared by Mr. Bryan in 1878:—"The site of the works was fixed by R. Townley Parker, Esq. (owner of the site and lands adjoining), and is most suitable for the purpose. The area of the ground is about 5¼ acres, and the locality is termed the 'Duckpits.' The position of the works is about 1½ miles north of the centre of Burnley, and a short distance south of Pendle Bridge. The Corporation has to pay a perpetual ground rent of 20*l.* per acre per annum for the land. The sewage, as it flows from the town to the works, is conducted across the Pendle Water by two iron tubes placed beneath the footway of a lattice girder bridge of 70 feet span. Corrosion of these tubes is prevented by keeping them always fully charged with sewage, thus leaving no part alternately exposed to air and water. Upon arriving at the works the sewage enters two catch-pits, at the outlet from which are fixed gratings, the spaces in which are ¾-inch apart. In the catch-pits the sand subsides, and is scooped out from time to time, while the gratings form a rough strainer and intercept filth of various kinds, which often consists largely of dirty cotton waste. Upon leaving the gratings the sewage receives a stream of milk of lime, which is pumped to this point from the mixing mill in the main buildings in the centre of the works. This part of the process requires careful supervision, both as to the treatment of the sewage and the quality of the cement. A measured quantity of carefully slaked lime is fed into the wash mill during every hour. This machine is an iron tank in which edge runners revolve. Beside it are fixed two pumps, one of which continually throws a stream of water into the mill, while the other forces the milk of lime, after passing through a fine gauze strainer, to the place where it enters the stream of sewage. The quantity of lime used at any particular time has to be proportioned both to the volume of sewage at that time and also to its quality, for it must be remembered that at some periods of the day, and on particular days of the week, the volume of the sewage will be much larger and its quality much fouler than at other times. An excess of lime above that required to combine with the suspended matter in the sewage has to be carefully guarded against. After passing the straining tanks, the sewage flows through a channel about 110 feet long. In this channel are fixed a number of inclined iron plates, which cause the sewage and milk of lime to be thoroughly mixed by gentle agitation. The inlets to the large precipitating tanks are about 2 feet 6 inches below the water level, and are 12 in number.

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By the time the sewage arives here, the lime has become thoroughly incorporated with it, and a curdling flocculent precipitate has formed. The tanks are constructed in two sets, each being an exact duplicate of the other. The first tak is 100 feet by 40, subdivided by an wall across the centre, for the purpose of retaining the bulk of the sludge in the first compartment. A channel and large sluice separate the second tank, which is also 100 feet by 40, from the first set; the total outside dimensions of coping being about 215 feet by 85. The whole of the walls dividing the various tanks are built in cement, the longitudinal wall having a heavy coping, the stones of which are cramped together. The outer walls are built in lias lime, and are backed up with concrete. The whole of the bottoms are of concrete, and in the first tanks the floors are brick on edge laid in cement on the top of the concrete. During the passage of the limed sewage through the tanks the precipitate subsides, the effluent water flowing away clear and inodorous to the gauge basin, and from thence into the river. The amount of sewage can be ascertained by actual measurement, by admitting the water into the tank forming the gauge and noting the exact time of overflow. The precipitate which falls to the bottom of the tanks very much resembles that swept from a macadamised road in wet weather. This sludge is removed from time to time by a direct acting steam pump, and delivered into the filter becks, where it parts with a great deal of its water. When taken from the precipitating tanks it contains 90 per cent. of moisture. The sludge in the precipitating tanks has to be carefully sampled from day to day, and if too much or too little lime be present from the cement point of view, the sludge has to be treated accordingly. After leaving the filter becks, in which it remains from ten to fourteen days, the semi-dry sludge is spread on a drying floor heated by furnaces, and cut with a rake into rough squares to facilitate the stacking in the kilns and to allow the steam to escape. After remaining on the floor for from 36 to 48 hours it is sufficiently dry for removal to the kilns. In these it is stacked with layers of coke, very much less coke being required than in burning Portland cement from the ordinary materials, as the sludge contains a large percentage of combustible matter. The kilns are of the ordinary kind used for burning Portland cement, and the burning is conducted in the same manner; but the products of combustion, instead of passing directly into the air, are conducted by flues into a tall chimney, first passing through a fire which

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effectually destroys the noxious vapours given off from the burning of organic matter. The resulting clinker, which has somewhat the appearance of engine clinker, is broken up and thrown into a perforated pan with large rollers running thereon, and as the material leaves the pan, an elevator carries it into a mill which grinds it very fine; it is then cooled on a floor to be ready for packing in casks or bags. Excellent hydraulic lime, quick setting, or Portland cement is produced. The Portland cement has been tested, and has withstood a high tensile strain. The effluent water, although not chemically pure, is good and quite clean enough to be admitted into the stream. The brightness of the effluent will be improved by filtration through gas coke, as is done at the Bradford Sewage Works. The drying space, cement stores, liming room, becks, and other works necessary for the Company's process have proved to be inadequate, although constructed larger than requested by Scott & Co., when the works were being designed. The sewage tanks are sufficient for the sewage of the borough, and have been laid out in such a manner as to allow of extension as the town grows without pulling back any work previously executed. No blame can therefore be attached to the Committee or their Engineer on account of the inadequacy of the works, so far as the cement process is concerned, as all the experience was with the Company. The amount of money expended by the Corporation at the Duck-pits for boundary wall, manager's house, bridge, sewers, tanks, sluices, gauge basin, the laying out of land, portion of the buildings, the steam engine, main shafting, sludge pump and suction and delivery pipes, double-acting pump, donkey pump, boiler, and wells, is about 8900*l.*"

Sewage Disposal Works (Present).

Upon the Corporation taking possession of the works in 1886, they discontinued the cement manufacture, but continued the artificial drying of the sludge over flues, but the nuisance arising from this process was so great, and the process itself so costly that, after visiting several towns, the treatment of sludge by filter pressing was determined upon, and a contract was entered into with Messrs. Johnson & Co., of Stratford, E., for the erection of four 30-chamber clothless presses. A portion of the existing buildings, used as an office and store rooms, was altered into a pressing room, and a sludge tank with a capacity of 200 tons erected. The necessary alterations

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to the sludge mains, pump, and engine were made, and two clothless presses with forcing machinery erected. A trial was made on March 22nd last year, but it was found, on applying the sludge to the filter presses under a pressure of 80 lbs. per square inch, that they did not do their work satisfactorily, and consequently, in accordance with a protective clause in the contract with Messrs. Johnson & Co., they were required to remove the clothless presses and to erect in their places two presses with cloths. This was done, and a trial was made with one press on June 24th in the presence of the Sewage Sub-Committee with very satisfactory results, which have been maintained. In addition to the work in connection with the sludge presses, extensive alterations have been made to the settling tanks and inlet channel; the two large tanks have been divided into four, so that there are now eight tanks of nearly equal size, and by an arrangement of sluices any one of these tanks can be emptied while the remaining seven are working. Before these alterations were made half the total tank space was in disuse while a tank was being cleaned out. The outlets from the sumps to the river have all been closed permanently, so that it is now necessary to pump the top water and sludge from any tank to be cleaned, the former being discharged into the inlet channel to the settling tanks, and the latter into the sludge tank. The only outlets to the river now are the two effluent outfalls, both of which will be abandoned when the land at Wood End—referred to hereafter—is laid out for filtration. The reason for blocking up the outlets from the sumps was that frequent complaints were made by property owners and their tenants lower down the stream that the manager of the works not only allowed the top water to flow into the river but also the whole of the deposited sludge in times of flood. It is now utterly impossible to do this. Improved screens have been erected for removing the coarser matters from the sewage before delivery to the settling tanks. The sludge tank is provided with an adjustable skimmer for the removal of the top water from the surface of the sludge. It is found that when the tank has been filled with sludge from the settling tanks and allowed to remain for twenty-four hours, about 12 inches in depth of water rises to the top of the sludge; this water is skimmed off and passes again through the settling tanks. It will be understood that, owing to the skimming arrangements, the bulk of sludge for treatment in the presses is very considerably reduced. The presses, which are three in number (the third having been erected on September 14th, 1889),

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contain forty chambers each, which turn out forty cakes of pressed sludge per press, the cakes being 36 inches square and 1½ inches thick, weighing 27 cwt. per press. The time occupied in reducing the wet sludge, which contains 90 per cent. of moisture, to cake containing about 50 per cent. of moisture, or say 6 tons 15 cwt. of wet sludge to 1 ton 7 cwt. of cake, is about an hour per pressing, and 15 pressings per day can easily be obtained from the three presses. The quantity of lime mixed with the sludge before pressing is about 150 lbs. per press. This lime is added to the sludge in the settling tanks before pumping to the sludge tank, so that a thorough incorporation of the lime with the sludge is obtained during the process of pumping. The liming arrangement erected by the patentee is now abandoned, as it is found that by the present liming arrangement the lime is more thoroughly mixed with the sludge, the result being better cakes at less cost.

The cost of pressing the sludge at the present time is about 2*s.* 1*d.* per ton of cake, or 5*d.* per ton of wet sludge; this cost is made up as follows:—Labour, 9*d.*; lime, 8*d.*; cloths, 5*d.*; coal, oil, repairs, &c., 3*d.* Comparing the cost of dealing with the sludge by the present process with that of the old process, it will be seen that everything is in favour of the present method. At the present time about 400 tons of sludge, containing 90 per cent. of moisture, are removed from the settling tanks weekly, and this quantity is easily reduced to 80 tons of cake by the three presses at a cost of 8*l.* 6*s.* 8*d.*; by the old process, and with the limited space, only about 275 tons of sludge could be dealt with. This method cost 1*s.* per ton for the wet sludge, or 13*l.* 15*s.* for the 275 tons, the remainder having to be deposited in the earthen becks until fit for carting away. Further, by the process of pressing there is no nuisance whatever arising from the works, which could not be said when the old process was in operation.

Since the commencement of filter pressing at these works on June 24th, 1889, and to the week ending May 24th, 1890, 2249 pressings have been made, representing 15,180 tons 15 cwt. of wet sludge, or 3036 tons 3 cwt. of cake; giving a weekly average of 316 tons 5 cwt. of wet sludge, or 63 tons 5 cwt. of cake. The cake is given away to farmers for fetching. Owing to the wet weather this season, a stock has accumulated. The average daily dry-weather flow of sewage is 1,600,000 gallons, and the quantity of lime added is about 8 grains per gallon.

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Sewage Disposal Works (Proposed).

The position of the liming mill being a source of much trouble and inconvenience, it is intended to remove this machinery and put it down near the screening pits, together with a small horizontal engine, which will drive the liming machinery and also work the screens. It is also intended to raise the roof of the press-room and to fix thereon a water tank.

Owing to the unsatisfactory state of the effluent, it has been decided to treat it by filtration through land before discharging into the river, and for the purpose a site at Wood End, on the banks of the river Calder, half-a-mile below Duckpits, has been acquired. The site contains about 63½ acres (including river area), of which 61 acres have been purchased from T. T. Townley Parker, Esq., at 187*l.* 10*s.* per acre, 2 acres from Lady Alexander Gordon-Lennox at 160*l.* per acre, and half an acre from Sir Ughtred J. Kay-Shuttleworth at 160*l.* per acre. The statutory notices for utilisation of this land (which is outside the borough), for filtration of the effluent from the settling tanks at Duckpits have been given, and detailed plans and estimates have been prepared with a view to obtaining the sanction of the Local Government Board to borrow the money required to carry out the work.

It is proposed to block up the present effluent outfalls into the Pendle Water from the precipitation tanks at Duckpits, and to convey the clarified sewage from the tanks to the farm in a concrete and brick conduit, about half a mile in length, 3 feet diameter or of equal sectional area, with a fall of 1 in 878. This conduit will be carried in as direct a line to its point of discharge as is compatible with economy as to excavation, &c., and at the same time high enough to command the whole of the acquired land, and, if it is found necessary, the long narrow strip of land (about 26 acres in area) between the proposed line of conduit and the Pendle Water. The existing footpath, from the footbridge over Pendle Water at Duckpits towards Wood End, will be abandoned, and a new footpath from the north-west corner of the boundary of the Duckpits Works to Higher Duckpits Farm constructed in lieu thereof. The existing occupation road from Higher Duckpits Farm to Wood End will also be diverted, and an 18-ft. road will be constructed in its place, following the line of the proposed

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effluent conduit to the entrance to the sewage farm, and then running alongside the proposed boundary wall to Wood End. This will be a great improvement on the existing road. It will have an even gradient corresponding to that of the conduit towards the farm and will be fenced in on either side. At the entrance will be a cottage for a farm manager, and a weighing machine and office. Along the easterly boundary of the farm a brick wall 7 feet 6 inches high is provided for.

Owing to the natural formation of the land (which has a fall of something like 30 feet from the highest to the lowest point), a very large quantity of excavation and filling will have to be done to bring the several plots level, and consequently a very considerable area of land will be taken up by banks and slopes. The nett available area for sewage filtration will be only 45 acres, the remainder being occupied by roads, banks, rivers, and waste—that is, the island and the narrow strips of inaccessible land bordering the rivers.

The clarified sewage from Duckpits will be discharged into a large distributing chamber at the entrance to the works. This chamber will be provided with three outlets, each commanding about one-third of the land. These outlets will be provided with penstocks, so that the whole of the clarified sewage can be sent on to any one of the three divisions of the farm, or it can be divided between any two or among all three of them. The distributing conduits are 24-inch pipes laid at such height as to efficiently serve the filtration areas. These conduits will be provided with distributing chambers with an outlet to each bed. The outlets are 18-inch pipes and will be fitted at their ends with a spreader of simple construction, the object of which is to prevent the continued flow of water washing up the ground, undermining the banks, or getting into the drains without its having first passed through a sufficient depth of soil. The distributing chambers will be fitted with oak sluices, to regulate the flow of the clarified sewage.

The subsoil is suitable for filtration purposes, being of a loamy nature; it will be drained an average depth of 6 feet, and the drains are shown to be 22 yards apart. 6-inch and 9-inch pipes only are used for draining the filtration areas; the intercepting drains, however, vary in size according to their required discharging capacity. Manholes and lampholes will be provided in suitable positions, for ventilation and inspection purposes, and where the

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gradients are flat, flushing arrangements will be introduced. There will be four effluent outfalls into the river Calder.

The estimated cost of these works, including cost of land, is about 27,000*l.* The plans of the proposed works are exhibited for the inspection of members.

The Duckpits and Wood End Works will provide for the disposal of the sewage from 2800 acres of the borough only; that from the remaining 1215 acres, which is in the Gannow watershed, having to be provided for elsewhere. The population of the Duckpits watershed is 80,000, that of the Gannow watershed 13,000. The sewage from a portion of the latter is treated by means of lime in a set of small tanks at Gannow in the western part of the borough. In consequence of the recent extension of the borough boundary, and the inclusion thereby of an area the mean level of which is below that of the present works, it is found necessary to dispense with the existing small works and to take the sewage further down the valley. A site has been fixed upon, and a provisional order for compulsory purchase obtained, and the drawings for the scheme are now in hand. The site of the proposed works is 3½ miles west of the existing Gannow Works, and 4½ miles west of the middle of the town.

New Parks.

A plot of land containing 28 acres has been presented to the town by Sir John Hardy Thursby, Bart., upon which the Corporation intend to expend 12,000*l.* in laying out the same for a public park. Competitive designs have been sent in, but no selection has yet been made. These designs are exhibited for inspection. The boundary walls, lodge, entrance gates, &c., will be carried out by the Corporation from designs which are now being prepared. In addition to this park, which is on the eastern side of the town, another, which is to be 20 acres in extent and situate on the western side of the town, will be laid out and completed by the trustees under the will of the late Alderman Scott, and presented to the town.

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Main Roads.

Before closing this paper, it will perhaps be interesting to members to learn that the Corporation of Burnley have recently been successful in two actions against the Lancashire County Council for the recovery of amounts for the maintenance of the main roads (which were 5 miles 6 furlongs 182 yards in length) in the borough, for the years ended March 25th, 1888, and March 25th, 1889. The first action was heard at the Manchester Assizes on December 5th, 1889, before Mr. Justice Grantham, and was for the balance of the account for the year ending March 25th, 1888. The amount of the account was 3584*l.*, half of which was claimed from the County Council by the Corporation. The County Council paid 711*l.* and refused to pay the balance; consequently, action was taken to recover the amount. The County Council refused to supply the Corporation with particulars of their objections to the claim, but were ordered by the judge to supply the same, when it was found that among other items disallowed was the cost of repairing the footpaths, and that 20*l.* per mile only was allowed for scavenging against about 100*l.* claimed by the Corporation. The work done on footpaths included the substitution of flagging for asphalte and ashes. Acting under the advice of counsel, the claim of the Corporation was amended, and only the cost of replacing flags and other materials with similar flags and materials was applied for, and evidence tendered to show that 80*l.* per mile for scavenging was reasonable. Judgment was given for 307*l.* (which included 40*l.* per mile for scavenging) and costs.

The second action was decided at the Manchester Assizes on March 11th, 1890, before Mr. Justice Charles. The amount of the account was 4360*l.*, half of which was claimed by the Corporation. (This account was rendered before the first action was decided.) The County Council disallowed all claims for maintenance of footpaths, scavenging over 30*l.* per mile, and generally clipped the account on the ground that it was excessive, and paid into court 1188*l.*, which they held to be sufficient for the maintenance of the main roads. As several claims were made for substitution of flagging for asphalte, and paving for macadam, the claim of the Corporation was reduced to 1788*l.*, and the County Council agreed to a verdict for this amount with costs.

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As many, if not most, surveyors have been under the impression, and have accepted the dictum of the County Council, that maintenance of footpaths was not chargeable to the County authorities, the decisions of the judges in favour of the Corporation of Burnley will now furnish authority for future claims for maintenance of footpaths. A case on similar lines to the Burnley cases (Warminster Local Board *v.* Wiltshire County Council) was decided by Justices Charles and Grantham in the Queen's Bench Division, on the 15th instant, in favour of the local authority.

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BURNLEY WATERWORKS—CANT CLOUGH RESERVOIR.

(1) Description by H. ROFE, Esq., Engineer.

The Cant Clough Reservoir has a natural gathering-ground of about 910 acres, and by means of the Dog Clough Catchwater an additional gather of 110 acres is obtained, making a total of 1020 acres.

The available rainfall is estimated to be 25 inches per annum, and to yield 1,581,000 gallons per day, giving to the stream as compensation water a continuous flow of about 500,000 gallons per twenty-four hours, and leaving for the supply of the town about 1,000,000 gallons per day.

The reservoir has been calculated to contain 264 million gallons. It is formed by an embankment across the valley, with an extreme height of 84 feet in the centre, and a length of about 416 yards, the top water level being 924 feet above Ordnance datum. The area of the reservoir at this level is about 38 acres.

Owing to the character of the strata met with in sinking the puddle trench, it was found necessary to excavate it to a much greater depth than originally contemplated. The sides and ends of the trench in certain places are protected by means of brick walls.

The embankment, when finished, will contain some 380,000 cubic yards of earth, shingling, pitching, &c. The width at top bank level is 40 feet, the inner bank having a slope of 3 to 1 for a depth of 40 feet below the level of the water, terminating with a benching 30 feet wide with a slope of 2 to 1. The outer bank has a slope of 2½ to 1 for a depth of 60 feet, with a benching 40 feet wide continued with a slope of 2 to 1.

A horseshoe-shaped outlet tunnel, 7 feet diameter, has been driven into the hill round the end of the embankment, through which the main to the town has been carried. The supply to the town and the flow of compensation water will be regulated by valves to be fixed in the valve shaft, and decanting pipes will also be provided to enable the supply to the town to be drawn off at different levels when desired.

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The Dog Clough Catchwater is a covered conduit 3 feet 6 inches diameter, horseshoe-shaped, about 500 yards in length, with a gradient of 1 in 917.

(2) Description by WILLIAM WILLIAMSON, Esq., Waterworks Manager.

The Act of Parliament giving the Corporation power to construct a reservoir at Cant Clough was obtained in the year 1883. The pipe line from Cant Clough to Heckenhurst was commenced in February 1884, and completed in July 1884. The length of pipe line is about 4000 yards, the diameter 15 inches, and it is capable of delivering at Heckenhurst, when the reservoir is full, 5,760,000 gallons in twenty-four hours. The cost of the pipe line was 4823*l*.

The contract for the reservoir was let to Messrs. Fotherby in the month of September 1884, who commenced at once to form a road from Hurstwood to Cant Clough. The sod cutting for reservoir took place on the 31st December, 1884, and by the specification ought to have been completed within three years from the date of contract being signed.

The length of embankment is about 440 lineal yards, and the length of cross section in valley about 440 feet (that is from foot of inside to foot of outside slope). The average depth of puddle trench (as per contract drawings) was 60 feet, least depth 18 feet, and greatest depth 80 feet. The average depth executed is 112 feet 9 inches, the least depth 30 feet, and the greatest depth 192 feet. The amount of puddle at present in trench and puddle wall is about 54,000 cube yards, the amount to put in about 14,000 cube yards.

The extreme length of reservoir from centre of embankment to top end of reservoir is about 726 yards. The cubical contents of embankment is about 300,000 cubic yards, of which 240,000 cubic yards are in position. The stone toe at foot of inside slope contains about 20,500 cubic yards.

The tunnel is horseshoe shape; the inner tunnel from reservoir to valve shaft being 6 feet diameter and 120 yards long, and the outer one from valve shaft to small water ladder, 7 feet diameter and 80 yards long. The stop piece and valve shaft consists of a massive piece of brickwork, its position being in centre of puddle trench.

Two 24-inch pipes are already fixed in the brickwork, for the

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purpose of emptying the reservoir in case of sudden storm or accident to the embankment. A 24-inch pipe is also built in the brickwork for the purpose of conveying water to the town; this pipe draws its water from near the bottom of the reservoir. Another 24-inch pipe will connect with the water in the reservoir at a depth of 30 feet from top water level, from which water will always be drawn for the use of the town, so long as the water is above this level, afterwards through the lower one.

The channel in course of construction on south side of the valley is for the purpose of an overflow. The boundary wall is 2545 yards long, 900 yards of which are already completed.

A catchwater channel from Dog Clough, near Sheddin farm, is yet to be commenced to convey the water from Dog Clough to the reservoir; the length is about 506 yards.

The land acquired from the Towneley trustees was 50 acres, bought out at a cost of 6500*l.*; and 13½ acres (nearly) from the executors of J. Hargreaves, at 5*l.* per acre per annum ground rent. The contract price for the construction of the reservoir was 59,811*l.* The amount paid to contractors to date is 95,494*l.* The amount expended on the Cant Clough account to date (including pipe line, land, Parliamentary expenses, and sundries) is 115,642*l.* The works are expected to be completed for 150,000*l.*

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DESCRIPTION OF VICTORIA HOSPITAL.

This building was erected by public subscription. The foundation stone was laid by Sir John Hardy Thursby, Bart., on May 24th, 1884; and the building was formally opened on October 13th, 1886, by H.R.H. Prince Albert Victor. The cost of the building was about 18,000*l.*, and the architects were Messrs. Waddington and Son, of Burnley and Manchester.

The following is a description of the building, prepared by Messrs. Waddington and Son:—"The hospital forms a welcome addition to the institutions of the town. The site is of an area sufficient to allow of the erection of a complete administrative department, out-patients' department, six ward blocks of equal area, and a smaller block intended to be used as a children's ward. The administrative block occupies the centre of the site. The front portion of central block contains on the ground floor, secretary's room, house surgeon's sitting-room and bedroom, matron's sitting-room, nurses' dining-room, linen room, matron's store-room, and the operating room. On the first floor are matron's bedroom, twelve nurses' rooms, bath-room, &c.; and the second floor has four dormitories for servants. Connected with the above block by means of a ventilating corridor are buildings of one story, comprising kitchen, scullery, pantry, wash-house, laundry, drying closet, &c. There is a basement story almost throughout, with rooms for patients' clothing, store-rooms, larders, dairy, heating chambers, storage for coals, &c., with a central communication to the upper rooms by means of a double lift. Spacious corridors connect the administrative and ward blocks. These corridors are glazed throughout, and it will be possible to remove portions of the frames entirely in the summer months. The main wards are circular in plan, having an internal diameter of 60 feet, and accommodating twenty patients each. Overlooking each ward is a nurse's room and a scullery, and to the rear of these apartments are two separation wards for single patients. The bath-room, closets, lavatories, &c., are detached by cross ventilated corridors. The general principle of the circular ward

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has, so far, been adopted in but two or three instances, the most notable being that of the Civil Hospital at Antwerp, and the actual results of the working of these institutions are looked for with the keenest interest. It is confidently expected that many of the difficulties and dangers arising from the known defects in even the later types of hospital construction will be avoided, that more perfect sanitary conditions will be attainable, along with more cheery surroundings for both patients and nurses. Those who have given most study to the subject are able to predict with tolerable certainty that there will be great improvements as regards the aeration of the several blocks, the softening of internal draughts and the maintenance of an equable temperature, and the facilities for the regular admission of fresh air and the extraction of foul air, the free admission of sunshine, and along with this a comparatively greater floor space and cubic area for each patient. In these wards, however, certain novelties of arrangement and construction, based upon the suggestions of Professor Marshall and others, find their expression in actual hospital building. Of these features the sun rooms are probably the most important. They are designed on the roof of each ward, being approached by a spiral staircase of easy gradient, constructed in the centre. They are glazed all round, and outside the sun room is a promenade some 12 feet wide, making a circuit of the block. The roof of the ward is formed in wrought iron and concrete, with surface of rock asphalte. The wards, bath-rooms, closets, &c., are lined with glazed bricks, the joints being pointed flush in Keen's cement. These bricks have been selected as offering the most impervious surface, and the ward floors, for like reason, will be laid in Austrian oak, waxed and polished. The windows of the wards are glazed with British plate glass, and are hung at the level of the impost. In the centre of each ward is a smoke flue, jacketed with extraction flue. Access is gained to the soot chambers at the foot of this flue by a subway running under the corridors. The subway contains all pipes for the hot and cold water, steam, gas, &c., which are placed in a manner admitting of easy inspection. Facilities will be afforded for cleaning out soot flues, fresh air trunks, &c., and the examination of sanitary fittings, without entering the wards. Calorifiers will be placed in convenient positions in these corridors, heated by coils, from which circulation pipes will be carried to baths and lavatories. Lifts and shoots will be provided from the wards, so that coal, ashes, foul linen, &c.,

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may be carried underground. The hospital has a dual system of heating. Thermhydric stoves are used in the wards, and open fireplaces throughout the building. A complete system of heating, however, has also been introduced. Steam pipes are carried round the main wards and in the rooms of the administratrix, whilst steam radiators are inserted in small wards, corridors, &c. Steam coils of varying degrees of power are erected in the central extraction shaft, to assist the ventilation. Fresh air is admitted at two heights in the outer walls, by Ellison's air diffusers and Sherringham's ventilators under control, as well as near the centre through the stoves, and the extraction takes place from the ceiling level next the staircase, trunks being connected with the central extraction flue. The ceiling is coved at the wall line, and rises towards the centre to render the extraction appliances more effectual. The whole of the staircases are in stone. Having due regard to the soundness of the construction, the internal details throughout are of the simplest possible character, but it is believed ample provision is made for the efficient and economical working of the institution. The out-patients' department, consisting of dispensary, surgeon's room, ophthalmic room, and drug store, is situated to the rear of the western block to the north of the corridor, the corresponding portion on the west being reserved for the children's ward. The entrance lodge and mortuary are arranged to the street line on the north side, the former building being in two stories. All the buildings are substantially erected in stone upon a bed of concrete covering the entire building site, and to a distance of 3 feet beyond the walls."

On Saturday last, 24th inst., the foundation stone was laid for a Children's Ward, which is expected to cost about 4000*l*.

The party visited the Victoria Hospital, opened about four years ago, at which place they were courteously received by Dr. Brown, one of the honorary medical officers.

After being introduced to the President,

Dr. Brown said: The distinguishing feature of this hospital is that the wards are of circular form, the advantages of which are very great, and such as will be obvious to you all. One fundamental advantage is that from whatever direction the wind is blowing, it blows right round the building, drawing out the foul air, and letting in pure air; so that the circular form leads to

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increased efficiency in ventilation. Another advantage is that whenever the sun is shining, at whatever time of the day, we have the sunshine coming right in upon the ward. A further advantage is in the position of the beds. In an ordinary parallelogram you have patients opposite one another at a distance of about 12 feet, and they overlook each other in a way very disagreeable in case of severe injury, for they cannot help seeing all before them. In the circular form of ward, with 60 feet of diameter, the patients opposite are out of sight entirely, and a sufferer has only his two neighbours, who are not so visible as those just opposite him in a rectangular ward. The heating is by means of steam pipes round the outside walls, which gives every bed-head exactly the same amount of heat, and that heat is put where it is most wanted. It is through the outside walls and windows where the cold breaks in, and here we have a uniform heat not secured by any other system. You will see from the register that the temperature does not vary more than four degrees in a day. In regard to the extraction of foul air, the circular form possesses a very great advantage, because the inlets for fresh air are all round the wall at an equal distance from the outlets for foul air. In that way we are able to keep the wards very much sweeter and cleaner, and are able to utilise space by putting more patients into the same amount of floor space than we could by any other form. Another advantage is that the beds are put on the outside, and there is a large space in the centre for administration, where also the patients can dine, &c., without being in too close proximity to those in bed. Then we make use of the space of the central block for patients. There is a promenade 10 feet wide, where they can go and have fresh air without leaving the ward. With regard to the heating arrangements, we have three thermhydric stoves, the best invented as yet; but we do not trust to them. We trust entirely to our steam heating, the secret of the success of which is that we have graded the pipes. We have quite obviated the disagreeable noise usually associated with steam heating. When the ward was opened by Prince Albert Victor, arrangements were made for the men to turn on the steam while the visitors were in the room. The pipes were then cold, but before they left they were quite hot, and all this was done without anything which has not hitherto been managed in steam heating. Our pipes are at a minimum temperature of 112°. Among the further advantages which the circular form of the ward possesses, is that a different view is presented from each

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window, which is altogether more pleasant to the inmates than the ordinary form. Our walls are made of glazed bricks, and the architects have been careful to round off the corners at the angles of the walls, and also in the roof, so that the place can be cleaned with very great facility, and there can be no accumulation of dust. It is over three years that the hospital has been occupied, and all that time the ward has never been without its occupants; and yet, from the appearance of the walls, it would almost strike you as being new.

DISCUSSION.

The PRESIDENT: I have much pleasure in opening the discussion, and in formally moving a vote of thanks to Mr. Button for the interesting day he has given the Association. I think our best thanks are due to him, not only for the preparation of the papers, but also for the excellent arrangement he has made, by which we have been able to see most interesting and varied works, and, by the inspection, to gain, I am sure, every one of us, a considerable amount of information. With regard to the sewage works which we first visited, I think we shall all agree with what Mr. Button has foreshadowed in his paper, that it is necessary for Burnley to do something more than what it is at present doing with the sewage from the town. We saw the effluent, and none of us, I think, can say that it complies with the clauses of the Rivers Pollution Act. Mr. Button very wisely has designed, and is about to carry out, a scheme by which the effluent will be treated on land. Sanitary engineers are pretty well convinced by this time, that a chemical treatment alone produces a very inferior effluent, and that it is necessary, in order to ensure success with regard to that effluent, to pass it, after a partial precipitation, over land, the great purifier which nature has provided. I will not go into any details with regard to the works, but will leave that to other speakers, who are perhaps better acquainted than myself with sewage works. I will pass on to the hospital which we had the pleasure of visiting on our return journey. I think every member who has taken any interest in the design of hospitals will agree with me that the one we saw is as perfect of its kind as any we have had the pleasure of visiting. In the hospital they have carried to a successful issue the circular form of ward, which is to all intents

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and purposes a modern innovation. Those of you who have read the discussions of the Sanitary Institute or other societies, where doctors and engineers are somewhat mixed together, will have observed that there has been considerable discussion and many a battle fought on the question of circular *versus* rectangular hospitals. Dr. Brown, who so cordially welcomed us, and so explicitly explained the working of the hospital, gave us all the reasons that I know of in favour of circular wards. Of course we, as engineers, look upon the other side to what the medical officer does, and that is the question of cost. I think the circular ward is undoubtedly more expensive than the rectangular. We saw there, for instance, circular-made glass to fit the windows. We also saw all the floor-boards splayed off so as to meet in a centre, and it is evident that form of building must be expensive. I asked Dr. Brown if he could tell what the cost of the ward had been, so as to compare it per bed with others. He was unable to do so, but he told me they would have a very good opportunity of judging in the new ward they were building, which was for children's beds only. This I calculated would come to 120*l.* per cot; of course the cot takes up less room than a bed, and probably for adult beds it would be something like 150*l.* per bed. That is a little over the average, and it is evident that the circular form of hospital is expensive, though I believe it answers its purpose admirably. The next visit we paid was that to the Cant Clough Waterworks. It is a difficult matter to criticise the works that one only sees in a very hurried manner, and also more difficult to criticise works when the engineer is not present. But this paper which has been placed in our hands tells rather a curious tale with regard to these works. I have only been able to glance at it, but when I draw your attention to the fact that the first sod was cut in December 1884, and the specification says that the scheme shall be completed within three years from that day, it is evident that the time has been very much exceeded. From just a cursory look at the works I am of opinion that it will be quite two years before the works are finished, therefore the extra time will be five years on the original contract. I only hope the contractor is secured, otherwise if any time clauses come in, no doubt the time penalties will more than pay the Corporation for the work they have carried out. In reading this paper, and also the explanation given us on the site, it appears that the reason for this extra time arises from the puddle clay embankment, which is of course

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designed to keep the water back. It was found that after they had sunk to a depth of 60 feet, which was the originally intended bottom, there was some doubt as to the stability and the imperviousness of the rock there found, and we are told that that was cut through to a depth of 192 feet from the surface of the ground. Well, gentlemen, we, as engineers, are staggered and surprised to hear of such a state of things, and I very much regret that, owing to the engineer who designed the works not being present, I am somewhat tied in the remarks I should like to make in regard to them. Passing on to the question of cost, the original estimate on the contract price was 59,811*l.* The amount already paid to the contractors is 95,494*l.*, and before these works are completed it is expected the cost will be 150,000*l.*, which really means 90,189*l.* on extras. We know that in engineering works very great difficulties are encountered, and here is a case where the most surprising difficulties have been met that I have ever heard of in the course of my engineering career. The contractors have evidently carried out their work most faithfully. We saw the excellent brickwork in the culverts, we saw the embankment well and solidly made, and there is no doubt, at least I will hope so, that when the embankment is completed, and the water is let in, that the clay wall will resist the enormous pressure of water behind it. You can judge what the pressure will be on the puddle wall at a depth of nearly 200 feet below the surface of the ground. I have very great pleasure in proposing a vote of thanks to Mr. Button for his paper, and for the most admirable day's proceedings which this Association has enjoyed. I only regret there are so few members present. I am sure when they hear of our good fortune at Burnley, they will be very sorry they have not joined us to-day.

Mr. Lobley: I rise to second the vote of thanks to Mr. Button for the trouble he has taken, and for the hospitality shown to us to-day. For my own part, I have been exceedingly interested in the works at Burnley for a long time. I paid a visit to Burnley at the opening of the sewage works, when Sir Henry Cole was living and flourishing, and when he was the means of introducing and furthering the interests of what is known as General Scott's Portland cement scheme. I was present with a deputation of our own town council. We thought then that General Scott's system was going to revolutionise the disposal of sewage. That has not taken place, and it is now done away with entirely, as far as cement is concerned. The next visit was five years ago,

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when we had a very good district meeting here, and saw several matters of very great interest. It has been very interesting indeed to see some of the works again under different conditions, and the rapid growth of Burnley is something remarkable. I very cordially second the vote of thanks to Mr. Button.

Mr. BLAIR: I regret I was not able to come to the proceedings at the opening to-day, but I joined the members at the sewage works, and was interested in the method adopted for disposing of the solid matters in the sewage. What did strike me as somewhat remarkable was that after the various processes in separating the solid from the fluid matter, the Corporation should give the sludge away. The cake, in the form in which we saw it, should produce a very considerable revenue. Nearly two years ago we saw the production of what was called an artificial manure, by a process of steam drying, instead of pressing it into cakes. It was finally turned out in almost a powder, for which the Corporation of Warrington obtained a value of 7*l.* 10*s.* a ton, possibly now 6*l.* a ton, owing to reduced values. Here, material which appears to have a very high manurial value is given away. I should like to know how it is that the Corporation are satisfied with simply getting rid of the stuff without receiving any value for it. I was very greatly pleased and instructed by the visit to the hospital, and the description Dr. Brown gave of the circular wards was highly instructive; but it did strike me that the circular ward was an expensive ward, and not to be recommended in all cases. From his reason for its adoption, I should take it that it is very well suited for accident cases, but not for infectious cases. Since I have been in Bootle we have built an infectious diseases hospital; there the object was to have as few patients in a ward as possible. The largest ward we have only holds eight, and from the nature of the cases received into infectious hospitals, I think it is distinctly preferable that the rectangular ward should be retained for this class of cases. There are many causes, in the construction of a circular ward, which would account for an increase of cost—circular glass and brickwork, radiated floor-boards, radiated roofings. These would increase the cost very largely; but there is no doubt that from the point of view mentioned by Dr. Brown, such a form is distinctly preferable for a hospital such as that we were shown, that is, one built from the utilitarian rather than the economical point of view. The works at Cant Clough were very interesting. It is certainly startling to be informed that the

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puddle trench went down a depth of 192 feet below the surface. We were shown in the wing trench that the natural inclination of the rock to which the puddle trench went down, rose rapidly in the direction of the reservoir from the dam, and it occurred to me that if sufficient borings had been taken, it would have been shown that by removing the dam a little higher up the valley, the same strata would have been reached at a much shallower depth. Of course that is only from the information gathered from the wing trench. We do not know that the inclination of the rock is in the same direction as the reservoir. It may be diagonal, and in that case the economy to be effected by removing the situation of the dam would perhaps not have been achieved. The only information we have is from the wing trench, and from that I judge that, owing to the shallower depth of the consolidated rock, by removing the dam a certain distance up the valley, the reservoir might have been reduced in storage capacity; but it would have immensely reduced the depth to which the puddle trench would have been taken.

Mr. BRIERLEY: I rise with pleasure to support the sentiments expressed at our reception to-day, and to add one or two observations on the paper submitted to us. Our friend from Bootle has referred to some difficulty with regard to the disposal of sludge at the sewage works, and made some allusion to Warrington. But having seen the difficulty Mr. Button has at Burnley, and knowing pretty well the conditions which prevail at Warrington, I say there is a great contrast between the two. In Mr. Button's case the surrounding land is nearly all pasture land, which will not require much manure; at Warrington you are surrounded by land of high agricultural value. The Cheshire and South-east Lancashire farmers use this artificial manure to a very great extent, and consequently the Corporation of Warrington are able to obtain high prices for their refuse. I think this fully accounts for the difficulty Mr. Button has in getting rid of the sludge. Mr. Button has also shown us what is to be done in regard to dealing with the effluent. Most of us know that what we have seen does not come within the provisions of the Rivers Pollution Act, but I have no doubt he will be able to keep it within these lines when he has got it on the land which is to be used for filtration. There will be the same difficulty, I suppose, with regard to what should be produced on this land, whether it should be put to culinary or agricultural uses, and Mr. Button will no doubt have some difficulty in finding a

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market for his produce. With reference to the Cant Clough reservoir, it is a gigantic piece of work, and one that took us all by surprise to see the enormous amount to which the dreaded word "extras" came—something like 250 per cent. on the original contract. It is enough to alarm the members of the council, and make them feel that they do not know where the extras will end. I hope the cost may not exceed the figure given in the paper. I have pleasure in supporting the proposal that we give our hearty thanks to Mr. Button for his kind invitation to-day.

Mr. C. F. WIKE: I only arrived in time to have a cursory glance at the sewage works, but should just like to say one word about the disposal of the sludge. I was about seventeen years in Leicester, and the question of the accumulation of sewage sludge became so urgent that the Corporation were compelled to consider their position, with the result that they have had to lease a farm of 1275 acres for broad irrigation, and intend abandoning the precipitation works altogether. The works were established in 1854, and were, I believe, the pioneer works of the precipitation process. When they were first opened the sludge was sold to a company at a certain sum; this sum was afterwards reduced, and the contract was eventually abandoned. The sludge was then made into bricks, but this was a failure. It was afterwards offered to agriculturists at a very low price, and ultimately it was given away to any one who would fetch it. Even then there was the greatest difficulty in getting rid of it. Scarcely any one would fetch it except a few gardeners whose gardens were close to the works. Not only in Burnley, but in Leicester, Sheffield, and other large towns, there is great difficulty in disposing of the sewage sludge, and I think Mr. Button is fortunate in getting it removed for nothing.

The PRESIDENT then put the resolution, which was heartily adopted, after which Mr. Boulnois congratulated the Corporation on having so efficient and capable an officer as Mr. Button.

Mr. BUTTON, in response, said: I thank you very much, Mr. President, for the kind way in which you have put the vote of thanks before this assembly, and to you, gentlemen, for the manner in which you have received it. I am glad to hear the President agree with me that the proper way to deal with the effluent from the sewage works is by passing it through land. With reference to Mr. Blair's remarks as to the disposal of sludge, and the fact that we derive no revenue from it, I should like to draw his atten-

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tion to the fact that around Burnley there is really no land of high agricultural value. I may mention that Dr. Campbell Brown, of Liverpool (our analyst), has valued our pressed sludge at 1*l.* per ton; this is a theoretical value, based on farm-yard manure at 16*s.* per ton, so that it is worth 25 per cent. more than farm-yard manure. Yet we are glad to get rid of it for nothing. At Leyton, in Essex, the local authority pays, I believe, 180*l.* a year to have it taken away, while at Coventry 2*s.* 6*d.* per load is received by the Corporation for every load fetched. Mr. Brierley made some remarks about the crops to be grown on the sewage farm. He expects that we shall have some difficulty in getting rid of these, but we do not anticipate any difficulty at all. Probably you will be surprised to learn that Skipton (a town 14 miles distant from Burnley) sends rye-grass from its sewage works into this town, and there is a ready sale for it. We on the spot expect to have a good sale for our crops, which will probably be rye-grass. As to Mr. Wike's remarks, we certainly do not intend to go into the brick-making trade and compete with local brick-makers, but shall be satisfied to continue with the present method of disposal of the sludge. We have a large stock of pressed sludge at present, but the reason for this is that, owing to the wet weather, the farmers have been unable to cart it on to the land; we hope to be able to clear it away as soon as the first crop of grass has been got. I beg to thank you most sincerely, Mr. President, for your kind remarks, and you, gentlemen, for the way in which you have received them.

Votes of thanks were unanimously accorded to the Mayor of Burnley for his hospitality and welcome, and for the use of the Town Hall. Also to the President, Mr. Boulnois, who suitably replied.

After an inspection of the new Town Hall, embracing police courts and baths, the visitors drove to the new storeyard at Daneshouse, which is conveniently situated between the Lancashire and Yorkshire Railway and the Leeds and Liverpool Canal. Railway lines are carried through the yard, with benches on each side for convenience in loading and unloading, and a large steam pillar crane with a 35-foot radius, and capable of lifting 3 tons, will be erected to unload materials from the canal. The sewage works at Duckpits were next visited, and the treatment of the sewage by Johnson's sludge presses explained by Mr. Button. On leaving

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the sewage works, the party visited the Victoria Hospital, which was fully described by Dr. Brown. The members then adjourned to the Bull Hotel, where they were entertained to luncheon by the Mayor and Corporation. The afternoon was occupied in paying a visit to the Cant Clough Waterworks, the leading features of which were explained by Mr. Williamson.

Votes of thanks were accorded to the Mayor for his reception, and for the use of the Town Hall; to Mr. Button for his paper; and to the several gentlemen who had contributed to the interest of the meeting.

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ANNUAL MEETING IN LIVERPOOL.

June 26th, 27th, and 28th, 1890.

ADDRESS OF THE PRESIDENT.

MR. H. PERCY BOULNOIS, M. INST. C.E., F.S.I., &c.,
CITY ENGINEER OF LIVERPOOL.

GENTLEMEN,—When last year I had the honour of addressing you as your President at Portsmouth, it was very far from my thoughts that such an honour would again be conferred upon me at Liverpool.

I need scarcely assure you that I did not willingly seek re-election, as the cares and duties of the office are by no means small; but when it was decided by the unanimous wish of the Council to ask me to again accept the Presidential Chair, I could not refuse, and you may believe that my best exertions will be used in the future year of my office, in the same manner as I hope they have been exercised in the past.

During the Association year which is now completed, we have held five District Meetings; and of the benefit which is derived by the members who attend those meetings, I cannot speak too highly. Opportunities are given for the inspection of municipal and other works in the various cities and towns which we visit, and these opportunities cannot but enlarge the professional knowledge of those members who avail themselves of the privilege of attending these meetings, and the knowledge thus acquired is, without doubt, of the greatest possible value to those towns which are represented by the members of our Association who are present at the meetings; and I cannot help thinking that some arrangement might, in justice, be made by the Corporations or Boards which govern these towns, by which the expense that now falls on their officers in

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attending these meetings should not be entirely defrayed by the officer. It will be of interest to the members to hear that this course is already adopted by a few Corporations, and within the last few weeks I have had the honour, as your President, of writing to the Mayor of Brecon upon the subject, with the result that, upon my letter being read at the Council Meeting, a resolution was passed that the Borough Engineer should be allowed a sum of money annually towards his expenses in attending meetings of the Association. I trust that this example which has been set by Brecon may be followed by other towns, as I feel sure that it is a step in the right direction.

The profession of an engineer is one that is only gained by knowledge and experience, and these are mainly acquired by practice, and by knowing what others are doing in their particular professional lines, for we thus learn in what manner the success of an undertaking is secured, and also how failures can be averted.

When we look at the multifarious duties of an engineer to a city or town, it is impossible to help being struck by the widespread character of those duties, which may fairly be summarised as follows:—

He has to design and maintain sewerage and sewage works, roads and streets of all descriptions, and frequently tram lines.

Sometimes, also, he is engineer for water and gas works, canals, docks, harbour improvements, river navigation, or for the protection of the coast against the encroachments of the sea, and the construction of flood works. He has sometimes to design and maintain bridges, hospitals, abattoirs, public baths and wash-houses, mortuaries, cemetery chapels, stables, police stations, and a host of other things too numerous to mention.

He is often required to lay out public recreation grounds, parks, or cemeteries. He is expected to know something of electricity, and also to be almost as thoroughly conversant with all the Acts of Parliament under which he works as would be a lawyer—in addition to which he must know something of the duties of an accountant.

Now it is in nearly all these branches of engineering that the meetings of this Association instruct; and I cannot too strongly impress upon the members present the importance of attending these meetings as often as their other public duties will permit.

During the past year much has been learnt upon the debatable question of the disposal of sewage, and, without going into details,

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I may call attention to the "Amines" process, and also the so-called "International" process, both of which we have had opportunities of inspecting.

With regard to sewerage works, many improvements have been made in the construction and design of sewage pumps, and in the form and construction of precipitation and other tanks, in the jointing of drain pipes, such as by Hassall's patent, and in many other details by which this class of work is materially improved.

With regard to roads and streets, concrete footpaths have made much progress, and wood pavement has been considerably influenced by the introduction of the Australian "Jarrah" wood.

In tramway construction, improvements have been effected in the form and method of laying the rails; and the electric cars which have been recently running on the North Metropolitan Tramway lines have shown such an advance in this method of locomotion as will permit me, I think, to predict that either this power or compressed air will, before many years have passed, take the place of the straining over-burdened horse. In water engineering, members have had opportunities of visiting some of the largest works in the kingdom, not the least that magnificent feat of modern engineering, the Vyrnwy Dam and artificial lake, which I am proud to say has been carried out by one of our members, Mr. George F. Deacon, M. Inst. C.E.

We have visited gasworks, where we have seen improvements in methods of charging retorts, and other inventions for the saving of labour or for the improvement in quality and cheapening of gas.

At a meeting last year at Sunderland, members were able to inspect the sea wall and promenade works at Roker, which have been so ably carried out by another of our members, Mr. R. S. Rounthwaite; and we shall none of us forget our visit to Leicester, where those splendid flood works were being rapidly carried to a successful termination, by the talented and ever to be regretted past President, the late Mr. Joseph Gordon.

It would take up too much of your time were I to recapitulate all the opportunities we have had of visiting and thoroughly inspecting and discussing the bridges, hospitals, abattoirs, and other works I have enumerated as appertaining to the professional duty of a Town Surveyor in the various towns and districts we have from time to time visited. But before passing on from this portion of my address I may mention that we have often discussed valuable papers in connection with various points arising out of

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the Public Health Acts; and with reference to electricity, I have had the pleasure, at this meeting, of presenting to Mr. E. J. Silcock, Borough Surveyor of King's Lynn, the First Premium of the Association, for his admirable paper on "Electric Lighting," which he read last year at the Annual Meeting at Portsmouth.

I congratulate you, gentlemen, upon the improved position of our Association. We now number 432 members, as compared with 384 when I last addressed you.

I believe that our registration, and proposed alteration of our title to that of the "Incorporated Association of Municipal and County Engineers," will give us even a better position than we hold at the present time, as we shall then have a *locus standi* in many matters, where before we could not be represented.

The objects of our Association are, as you know, the furtherance of the knowledge and practice of Municipal Engineering work; the general promotion of the objects of Sanitary Science; and the promotion of the professional interests of the members of the Association.

With the exception of the Inaugural Address in the year 1873, by the father of this Association, Mr. Lewis Angell, the President's address has always spoken solely of matters which have been directed more to the advancement of Sanitary Science than on the "promotion of the professional interests of the Members of the Association;" but it is upon this latter point that I should like to say a few words before concluding my address.

Mr. Lewis Angell, in 1873, spoke very strongly upon the question of Local Government Board protection for town surveyors, and he gave many reasons why such protection ought, in justice, to be afforded them, and recent events in one or two towns will show that even officers who have faithfully served their Corporations or Boards for many years are liable to have their services dispensed with at almost a moment's notice, and that without the slightest compensation or pension being awarded them. There can be no doubt that it is the duty of our Association, by combination of its members, to protect ourselves from the mere whim of an ever-changing body, such as Corporations and Local Boards are by their constitution, and there can be no question that our position requires improving and more recognition.

Sanitary engineering as a profession is only forty years old, and at present no diploma is necessary in order to distinguish a man who is fitted to hold the post of chief engineer to a Corporation or

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Local Board, and one, however worthy he may be, who does not hold the professional knowledge requisite for such a task.

It is possible, and very often we see it done, that a plumber may put after his name the words "sanitary engineer," and this necessarily gives a very misleading idea as to what a sanitary engineer really is, and of the qualifications necessary to become what we, professional men, understand by such a title.

Our Association has, as you are aware, instituted examinations by which certificates of competence are granted to candidates who voluntarily present themselves and are able to pass this examination, and I venture to believe that if this line of action pursued by our Association is properly supported, the certificates thus granted will eventually be regarded as "diplomas" under which an individual may be recognised as really a Sanitary Engineer competent to hold municipal office.

I am of opinion also that Municipal Officers should, like all Government officials, and even Officers of Poor Law Boards, be entitled to a pension after a certain number of years service.

A system might easily be arranged under which a fair percentage of the officer's salary should be placed in a superannuation fund, which could be added to by the Corporation or Board out of the rates, provided an Act of Parliament were obtained for this purpose; and when an officer became too old or too feeble for further work he might retire on such a pension as he was entitled to under the scale.

I am convinced that something of this kind would go far to cement the good feeling which should exist between Municipal Officers and the Corporations and Boards they serve. It would also tend to allay any restless feeling which may exist in an officer's mind, as to whether he ought to stay in the position which he holds, or seek other service; and it would, I believe, add to the energy and attention of an officer, as he would feel relieved of anxiety and care for his family in the event of his retirement from ill-health or from death. It would further go far towards preventing fraud, and would be hailed with acclamation by every member of our Association.

The Corporation of the City of Manchester has, I understand, recently set a good example in this direction by applying for an Act of Parliament to empower them to form a superannuation fund and to pension their officers; and the Corporation of Liverpool, which has at present an incomplete Act under which it does not appear

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that any pensions can be granted to officers who have joined the service since a certain date, although a percentage of their salaries is stopped for the purpose, will no doubt obtain an Act to change such an anomaly.

I am also of opinion that officers should be appointed on a sliding scale of salary, in order that they may have something to look forward to in the event of their doing their work faithfully and well, and that they should be spared the necessity of going through the almost ignominious proceeding of asking for an increase of salary, when it is evident that they are clearly entitled to such an increase when the experience of the intricacies of their work makes them become more valuable.

I have placed these matters before you for your consideration, as, from recent events, I feel that the time has come when Corporations (or I should rather say the public) ought, in justice, to recognise and definitely settle the position which an engineer employed by a Corporation should hold, and that those officers should be placed on a similar footing to that of Government officials, Railway officials, and almost every other class of official throughout the country.

In conclusion, allow me to apologise for this rather hastily prepared address, but I know you will believe me when I say that it has been written during moments snatched from a particularly busy time; and permit me also to say that I shall endeavour, during my second year of office, to still further advance the interests of the Association to the best of my power and ability.

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THE LONDON SEWAGE QUESTION.

By CRAWFORD BARLOW, B.A., M. Inst. C.E.

Introduction.

The Metropolitan Board of Works' scheme for the main drainage of London, so ably designed by, and constructed under the supervision of, Sir J. Bazalgette, was laid out to deal with the sewage of a population of 3½ millions. That is to say, in designing the system in 1856, provision was made for an increase of population for about twenty years in advance. In 1875 the population of London reached that figure, and since then the system has been overcharged.

In addition, the arrangement for the disposal of the sewage by discharging it into the Thames immediately outside the metropolitan area, was only sanctioned on the understanding that a more complete system of disposal was to be arranged as soon as practicable.

As the late Metropolitan Board seemed indisposed to take any steps, either to meet the requirements of the increasing population, or to complete the system as originally contemplated, and as the nuisances arising from these two causes produced such a widespread feeling of dissatisfaction, numerous inquiries, culminating in a Royal Commission, were instituted.

The late Metropolitan Board accordingly laid out a scheme which, now that its consequences are becoming more manifest, is attracting a great deal of adverse criticism. And as since then a change in the government of London has taken place, and the course proposed is consequently being reconsidered, the present was thought by the author an opportune time to review all the circumstances, with a view of considering whether the Metropolitan Board's proposals are open to the objections which have been raised against them, and if so, whether there are better methods to be devised.

The defects of the present sewerage system were anticipated as long ago as 1858 by the referees (Captain Galton and Mr

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Simpson) in their reply to Messrs. Bidder, Hawkesley, and Bazalgette's report, in the following words :—

"That the limited provision for rainfall in the sewers proposed by Messrs. Bidder, Hawkesley, and Bazalgette, would cause the sewage too frequently to overflow into the Thames within the metropolitan district."

"That the proposition to throw the whole sewage of the metropolis in a concentrated mass into the Thames at Barking, close to the metropolitan boundary, would not prevent the sewage from returning within the metropolitan districts, and would be injurious to those eastern districts of the metropolis which lie adjacent to the Thames, the population of which is rapidly extending, in consequence of the great increase of the commerce of the port of London."

The author proposes to refer very briefly to the facts elicited by the Royal Metropolitan Sewage Discharge Commission (1884).

I. Those concerning discharges of the sewage into the river resulting from the limited provision for rainfall.

II. Those relating to the nuisance caused by the present method of disposal.

I.—Facts concerning the Discharge of Sewage into the River, resulting from the Limited Provision for Rainfall.

In the evidence in regard to this the following occurs. Mr. Baldwin Latham says, "Every time it rained in London the sewers must overflow at some point or other," and "more overflows are now being constructed, the effect of which will be to bring the sewage and rainfall combined to a greater extent into the upper part of the river." Mr. H. Law attributes the necessity for more storm overflows to the fact that, owing to the greater surfaces which contribute the rain to the sewers, a larger quantity of rain is carried away through the sewers; again, he says, that as the natural watercourses have been filled up, it has been necessary to substitute artificial watercourses in the shape of overflows, or, more properly, relief sewers, to them.

The evidence before the Commission showed that in the original scheme a certain number of storm discharges were provided; but when the system came into operation these were found to be

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insufficient, with the result that a great many floods ensued in the low-lying districts.

The Metropolitan Board of Works in their Report of 1881 refer to this as follows:—

"The floodings from heavy storms of rain which have occurred on several occasions in recent years in some of the populous suburbs of London, principally those on a low level, made it necessary for the Board to determine upon the construction of some additional large sewers to carry off the storm water."

The Report of the Commission says:—"The weakest points of the present system are the necessity for storm outlets, and the discharge of the sewage in its natural crude state;" and "the storm outlets are a necessary consequence of the limited general capacity of the intercepting system, and of the sewers having to carry off the sewage and the storm water combined;" and they go on to say this is "an evil which, if it exists at present, *must increase* as the population extends;" and again, "the storm discharges, as an element of imperfection in the drainage system, cannot be ignored. It is in evidence that *they are being largely increased.*"

From these extracts it will be seen that the inadequate provision in the sewers had been recognised, to a certain extent, by the late Metropolitan Board of Works, but was dealt with by them by constructing more storm overflows, a course to be strongly condemned, because such an arrangement entails discharges of sewage into the Thames in the heart of the metropolis.

II.—Facts concerning the Nuisances caused by the Present Method of Disposal of the Sewage.

The record given by the Commission of the different inquiries which were instituted, is the strongest evidence of the nuisances arising from the present method of disposal, viz., by discharging the sewage into the river at Barking and Crossness.

The first of these was in 1868 (three years after the main drainage system had come into operation), and between that time and 1880 there were four inquiries; these, however, not having accomplished the result desired by the complainants, the Royal Commission of 1882 was appointed.

Their two Reports issued in 1884 are so well known that it is

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unnecessary here to do more than to refer to the paragraphs in them relating to this point, these are as follows:—

"That the discharge of the sewage in its crude state during the whole year, without any attempt to render it less offensive by separating the solids or otherwise, is at variance with the original intention, and with the understanding in Parliament when the Act of 1858 was passed."

"That the discharge from the main outfalls becomes very widely distributed by the motions of the water, both up and down the river, being traced in dry seasons through the metropolis, and almost as high as Teddington, and that it oscillates for a long period before getting finally out to sea."

"That in hot and dry weather there is serious nuisance and inconvenience, extending to a considerable distance both below and above the outfalls, from the foul state of the water consequent on the sewage discharge. The smell is very offensive, and the water is at times unusable."

"That foul mud, partly composed of sewage matter, accumulates at Erith and elsewhere, and adheres to nets, anchors, and other objects dropped into it."

"That sand dredged near the outfalls, which used to be obtained in a pure state, is now found to be so much contaminated with sewage matter as to be unusable, compelling the dredgers to go further away."

"That for these reasons the river is not at times in the state in which such an important highway to a great capital, carrying so large a traffic, ought to be."

"That this discharge adds largely to the quantity of detritus in the river, and so must increase the tendency to deposit."

"That the evils and dangers are likely to increase with the increase of population in the districts drained."

And in their second Report they say:—

"Our opinion of the evils described in our first Report as resulting from the present system under which sewage is discharged into the Thames by the Metropolitan Board of Works is much strengthened, and we believe these evils imperatively demand a prompt remedy."

"We are of opinion that it is neither necessary nor justifiable to discharge the sewage of the metropolis, in its crude state, into any part of the Thames."

The Commission having elicited the facts, and reported thereon,

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concluded by drawing up a series of recommendations, which, when summarised, are as follows :—

I. That in new drainage works the sewage should be *separated* from the rainfall.

II. That the sewage should be disposed of by :—

(*a*) Some process of deposition or precipitation to be used at the present outfalls or at outfalls at Hole Haven.

(*b*) Disposal of sludge.

i. Either to be used to raise low-lying lands.

ii. Or dug into land.

iii. Or burnt.

iv. Or carried to sea.

(*c*) Disposal of liquid. This may *temporarily* be put into the river, but,

i. Ultimately it is to be purified by intermittent filtration on land.

ii. Or discharged into the river at Hole Haven.

In the last clause there is a suggestion pointing to a general extension of the drainage system to the whole of the districts round London, as recommended by Sir J. Bazalgette and Mr. Baldwin Latham.

The late Metropolitan Board of Works, who previous to the appointment of the Commission had always disputed the existence of nuisances from the sewage disposal, were now compelled to take some action, and the course they decided on may best be gathered from their final Report of 1888. The paragraph referring to the matter is as follows :—"The Board accepted the conclusions of the Commissioners as far as related to the separation from the liquid sewage of the matter held in suspension," and of the sludge; but, concerning the liquid the Report continues :—"The Royal Commissioners advised that after the precipitation of the solid matter in the sewage, the liquid should be further purified by intermittent filtration through the soil, if it were decided to allow the effluent water to pass into the Thames in the neighbourhood of the present outfalls. The Board carefully considered this point, but found that the acquisition of sufficient land in the neighbourhood of Barking and Crossness, to enable the vast quantity of London sewage to be effectually filtered through the soil without nuisance to the inhabitants of the locality, would be attended with almost insurmountable difficulty, and that the cost would be enormous. It was, therefore, a great satisfaction to be assured upon competent

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authority that there was another method (chemical process) of purifying the sewage, sufficiently effective to obviate the necessity of earth filtration."

It may be pointed out that they thus only carried out the recommendation of the Commission as regards precipitation and barging the sludge to sea; they did not attempt to deal with either the incapacity of the sewers or the disposal of the liquid, as recommended.

Having thus sketched out the state of the case, it is proposed to discuss the recommendations of the Commission, and the action of the Metropolitan Board—I. On Separation, II. On Disposal—with a view of arriving at suggestions for future action.

I. Separation.

The main object of separation is to increase the carrying power of the present system.

Since its completion the population has been rapidly increasing, until now it is a million more than that for which the scheme was designed. During this time an additional sum of £1,650,000 (over and above the original outlay of £4,600,000) has been spent for the storm overflows and extension of reservoirs at the outfalls. These works are, however, not extensions of the main drainage system, but "relief" works. The storm overflows are, as the Commission says, "the necessary consequence of the limited capacity of the intercepting system."

Practically the Main Drainage of London is, as regards carrying capacity, as it was when completed. From the figures given before the Commission, the main outfall drains are capable of carrying 420 million gallons of liquid daily, which was estimated in the original scheme approximately as follows:—105 millions for sewage, and 315 millions for rain.

The daily amount of sewage has now increased to 133 millions, so that the available space for rain has been diminished to 287 million gallons, that is, the carrying power of the outfalls, as regards rain, is reduced by 28 million gallons daily.

But we have it in evidence that the rain water which has to be conveyed away increases as the area becomes more built upon, so that we are face to face with this fact, that while the quantity of rain water to be conveyed away is increasing, the available space in the sewers for carrying it away is diminishing.

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The evidence thus shows that the present sewers are not sufficient to carry away both rain and sewage, and the question resolves itself into this:—Which is most expedient? To enlarge the present system (involving necessarily extra pumping arrangements), or to make conduits to carry away the rain direct to the river?

The above considerations are based on the assumption that the intercepting and outfall sewers are only called upon to carry the sewage of the Metropolitan area. The evidence, however, showed that these sewers are being requisitioned to carry the sewage of districts outside, such as Acton, Beckenham, Hornsey; and the Report of the Commission recommends an extension of this arrangement. This is increasing the duties of the London sewage system to an extent which was not contemplated at the time when the original powers were given and the original design prepared, and makes "separation" all the more necessary.

The objections to "separation" were chiefly made on the ground of interference with private property, and consequent cost.

The remedy suggested for consideration is *a partial separation;* for example, let the surface water from off all roads, open spaces, public buildings, churches, chapels, &c., be conveyed direct to the river (say by the present storm overflows); also let intercepting conduits be made parallel to the old water-courses, such as the Fleet, the Ranelagh, the Effra, &c., and convey all fresh water which is supplying these to the Thames. In this manner a large amount of rain and fresh water would be separated from the sewage *without any interference whatever with private property.*

"Separation," too, has a most important bearing on the question of "disposal." On this point the Commission speak very strongly:—"We consider that this (separation of sewage from rainfall) is a matter of much importance, in whatever way this disposal may be effected. If it is to be used on land or treated chemically, its concentration and uniformity are highly desirable; and if it is to be carried further away by a long conduit, its volume should, from motives of economy, be reduced to a minimum."

The above considerations point to the necessity of a separation of rain and fresh water from the sewage, because such an arrangement would leave more accommodation in the sewers for the sewage proper, and thus diminish, if not altogether do away with, the present system of storm overflows, which discharge sewage into the river in the heart of the Metropolis, and would also lessen the

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amount of liquid which has to be pumped into the outfalls, and has to be finally disposed of.

II. Disposal of Sewage.

There is no doubt that the "Water Carriage System," while reducing the difficulty of relieving cities of their sewage, has increased the difficulties of disposing of it. The Commission, in their second report, give a record of all the attempts that have been made to solve this problem.

Between the years 1857 and 1876 there were ten inquiries as to the best method of disposal of sewage, and almost, if not the whole, of these reports, recommend the disposal by irrigation, or land treatment.

Besides these general inquiries there have been numerous special ones, amongst which may be mentioned the Birmingham Corporation 1871, the Glasgow Corporation 1880, a Local Government inquiry on the Lower Thames Valley Main Sewerage First Scheme 1880, a second inquiry into the Lower Thames Valley Second Scheme 1884, and, lastly, the Royal Commission of 1884, to which we are referring.

These, of course, treat particularly with the special characteristics of the locality in each case.

In the case of Birmingham, the Corporation was recommended to adopt a lime treatment, on account of the special character of the sewage, with ultimate treatment of the effluent by irrigation.

At Glasgow, the report said: "Filtration through cultivated land, i. e. irrigation, is probably the best means of purifying the sewage."

At the Lower Thames Valley Inquiry (first scheme), special circumstances led to the rejection of an irrigation scheme; these were, that the subsoil, though admirably suited in other respects, was unable to drain itself when the Mole, the Ember, and the Thames were in flood; that the question of free drainage of the subsoil was complicated by the existence of a large amount of underground water, and that as the Lambeth and other water companies were drawing their supplies from the subsoil, there was a liability to pollution of their water.

At the inquiry into the Lower Thames Valley Second Scheme, the scheme (which adopted chemical processes entirely) was reported favourably upon; but eventually it was rejected by a

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Committee of the House of Commons, who made the following important recommendation:—"That in these cases the process of filtering the chemically purified effluent through earth ought, if possible, to be adopted."

The recommendations of the Commission of 1884 have already been given.

From the foregoing it appears that whilst there are a few cases in which local circumstances make a land treatment of sewage inexpedient, the preponderance of scientific evidence is in favour of the sewage being so disposed of and purified.

Since 1884 there have been two important Commissions: one in Paris in 1888, and the other in Melbourne in 1888–9, and the Report of this latter gives much information as regards the arrangements both at Paris and Berlin. As the populations of these two cities are nearest in numbers to that of London, their experiences should be of material assistance in the solution of this great problem; a few extracts are accordingly given.

The Sewage System of Paris.

With regard to Paris, it may be as well to recapitulate that, in 1870, a Commission decided that, to remedy the evils arising from the discharge of the sewage into the Seine, "the city of Paris should continue and develop the experiments undertaken at Gennevilliers for the purification of the sewage by applying it to irrigation and by sulphate of alumina." In 1878, Mr. F. Tarbet, in a paper before the Institution of Civil Engineers,* writes:—"The process of precipitation by sulphate of alumina having been tried and abandoned, the project of utilising the sewage by irrigation in the plains of Gennevilliers has been adhered to, and is now progressing, slowly indeed, but with every apparent chance of success."

It is not necessary to give particulars of the Gennevilliers Farm as it has been so often described, but the opinion of Dr. Drysdale with regard to it, as given to the Melbourne Commission, is worth recording; he writes:—"So rapid has the progress been, and so completely has all opposition disappeared on the part of the inhabitants of the plain of Gennevilliers, that at present more than 600 hectares, or 1500 acres, are cultivated by the aid of the

* Min. Inst. C.E., vol. liii. p. 208.

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sewage, and 20,000,000 cubic metres are employed annually. The prosperity of the plain, and even its salubrity, have been greatly augmented since the introduction of the sewage irrigation, for in five years the population has increased 34 per cent., and the annual rental value of the land has increased from 90 francs per hectare to 450 francs per hectare, i. e. the land of the plain is now five times as valuable as it was when the irrigation commenced. The people of the village have therefore demanded that the water of the sewage shall be given to them gratis for twelve years, subsequent to the year 1881; whereas, in 1878, when I visited it, many of the peasants complained greatly. It is now well known in Paris that our actual plan of treating sewage with chemicals, as is done at Crossness, is hopeless, and far worse than useless. The amount of market produce per hectare at Gennevilliers is quite surprising; such as 40,000 heads of cabbages per hectare (16,000 per acre); 60,000 heads of artichokes (24,000 per acre); 100,000 kilogrammes of beet per hectare (40,000 per acre, or about 40 tons). The cultivators raise a gross value of from 3000 francs (£120) to 10,000 francs (£400) per hectare, or from about £50 to £150 per acre. Vegetables are the chief produce at Gennevilliers, and, besides these, nearly 800 cows are fed on the grass grown on these farms. The effluent from the farms at Gennevilliers is so perfectly filtered and purified by the passage through the soil that I drank it, and it is habitually used by those who live close by to cook with, &c. Thus is the filthy sewage restored to the Seine in purity, as our Thames sewage should be."

But the strongest evidence that the Gennevilliers Sewage Farm is a success is that, in 1888, the French Senate, after a long investigation before a Special Commission, who carefully studied both the Gennevilliers Farm and the system of Berlin, adopted a *projet de loi*, having for its objects the extension of the sewage farms of Paris and the purification of the Seine. "The intent of the Bill is to conduct into the peninsula of St. Germain the sewage of Paris raised by the machines at Clichy, the expense being borne entirely by the city of Paris. The State is to lease to the city for twenty years about 2000 acres of State lands in the peninsula, at an annual rent of about £4000, the city having the right to purchase, during or at the end of the lease, for about £140,000. Sewage water is to be distributed only on lands under cultivation. In order to avoid saturation, not more than 21,000 cubic yards must be placed on each acre per year; no stagnant pools must be

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permitted to exist; and no unpurified sewage is to be diverted into the Seine, in the department of the Seine and Oise, except in case of absolute necessity (*force majeure*). The whole is to be under the supervision of the city officers (*agents de ville*) and under the permanent control of a commission of four experts, nominated respectively by the Minister of Agriculture, the Minister of Finance, the General Council of the Seine, and that of the Seine and Oise. The Senate was advised to add a fifth expert—a member of the Comité Consultatif d'hygiène de France, chosen by that committee. The Commission was to report yearly (or, as the Senatorial Commission recommended, twice a year) to the Ministers of Agriculture and Finance."

The Sewage of Berlin.

With regard to Berlin, the following particulars of the sewage arrangements are given in the Melbourne Report:—

"Berlin, with a population of 1,400,000, covers 6178 hectares (15,266 acres) of the flat sandy plain which is characteristic of North Germany. The average rainfall of the year is 600 millimetres (23·6 inches), the daily water supply is 72 litres (15·84 gallons) per head, and the volume of sewage (which has all to be raised by pumping) amounts to 100 litres per head, or a total volume of 140,000,000 litres (30,800,000 gallons) per day.

"The city is laid out into twelve drainage districts. In seven of them the works have been completed, and the system is in full working operation. Each district has its own pumping station, whence the sewage is forced through cast-iron pipes to the sewage farm. Large tracts of land have been acquired on all sides of the city, but especially on the north and south, for irrigation purposes. The farms are, for administrative purposes, formed into four or five groups, and each group is controlled by a general manager.

"The present municipal farms have a total area of 4453 hectares (10,004 acres), of which only 2744 hectares (6780 acres) are irrigated; and only 1503 hectares (3719 acres) of the irrigated portion have been drained."

To this should be added the testimony of the members of the French Senatorial Commission, after having visited these farms for the purpose of making their report concerning the Paris sewage question.

"The Berlin experience seems to us as conclusive as possible, and in every point comparable with that of Gennevilliers. Let us

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only remember the fact that with sewage five times more charged with fæcal matter than that of Paris, the health of the cultivators and of the inhabitants of the domain is perfect. There is no typhoid fever. The city of Berlin has already established two convalescent homes in the houses of its domains: it is about to found two others in the very middle of its irrigation fields. Typhoid fever has diminished at Berlin till it represents only one-third of what exists in Paris. The towns and villages which are close to the sewage farms make no complaint, and their sanitary state is excellent. Part of the effluent from the sewage farms of Berlin is collected in an ornamental lake in which fish breed freely. This fact alone suffices to show how thoroughly all putrescible matter is removed from the sewage in a well-arranged, well-managed irrigation farm. The chemical analyses of the effluent water from the farms tell the same tale."

Dr. Cornil (President of the Commission) says:—"We visited the northern sewage farms of Berlin on July 6th, 1888; the southern on July 7th. From the station of Pankou we walked across the farm of Heinersdorf as far as the houses on the farm of Blankenburg; we admired, as we walked past, the fine fields of cereals—wheat, oats, and barley—and the nursery gardens of plants of various kinds and of fruit trees, some fields of flowers or medicinal plants, and others with hemp, colza, vegetables, &c. We walked along the open ditch in which flows the little river (Fliess Grabae) formed by the junction of the drains, and which carries off the sewer water after it has been filtered through the soil. This water is as limpid and pure as possible, although it flows in the open air, and receives the debris of the leaves of the osier beds which grow along its sides. We drank of it, for we knew beforehand that chemical analysis showed it to be destitute of organic matter, and to contain fewer microbes than spring water does.

"In the farm of Malchow, the farm house or chateau which is to become the site of a new convalescent home, is surrounded by a park full of old trees, the shady alleys of which conducted to a lake of about four or five hectares in superficies (10 to 12½ English acres). This lake receives all the water of the Malchow drains, and the water is so pure that trout are reared in it, and the products of the fishery are estimated at a value of £15 per annum. The choice of these sites for convalescent homes, in the midst of and close to the irrigated fields fertilised by the sewage of Berlin, shows in the most striking way the innocuousness of this neighbourhood.

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There are no bad odours, and no complaints are made by the convalescents. At Malchow we visited the farm buildings, and especially the cow-houses. In an immense house we saw about 100 milch cows (of Dutch breed), the milk of which is daily sold in Berlin. In the fields of Malchow the meadows of rye-grass especially struck our attention. The fourth cutting was being made of grass as green, as thick, and as straight and high, as can be imagined. Seven cuttings are annually made of the same value."

"On July 7th, we visited the farms situated to the south of Berlin, and the workhouses of the city. At Heinersdorf we admired the site of another convalescent home, in the midst of a beautiful garden near a little lake. We have even eaten magnificently fragrant strawberries grown on the irrigated fields. The same intense culture was noticed in the fields with grain crops, and in those with vegetables and fruit trees."

"The drains of the farms of Osdorf and Heinersdorf flow into the Lake Tettow. The water is absolutely pure and limpid; several of our number drank of it. It contains numerous little fish. The lake is situated at the end of the gardens and fields belonging to the school of cadets at Lichterfelde."

M. Virchow also says:—"The actual organisation of the town of Berlin is the best of all in this respect; the agricultural utilisation through the soil purifies the water. I myself have watched and carefully checked the sanitary state of the inhabitants of the Berlin farms. Every case of disease is noted; I receive the notice and make an inquiry into each case. The results of these observations are all published in the annual reports of the deputation, and they disclose an excellent condition of health among the workers on the farms, and in the neighbouring villages. There has been no case of typhoid fever."

The foregoing descriptions afford very strong evidence that a land treatment of sewage, *unassisted by any chemical processes, is feasible on a large scale;* that it is thorough as a purifier; that what opposition there was (and we have it that it was great at Gennevilliers) has been overcome.

But to return to the Metropolitan Commission of 1884:—

With regard to other methods of disposal, the Commissioners classified the various schemes brought before them into six.

I. Broad irrigation.

II. Filtration through land.

III. Processes of deposition or precipitation.

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IV. Precipitation supplemented by application to land.

V. Removal of the outfalls lower down the river.

VI. Removal of the outfalls to the sea.

And their opinions as regards these may be concisely stated as follows:—

I. Would be matter of great difficulty, on account of enormous quantity of land and consequent cost and opposition.

II. Would be applicable, under certain conditions, to the metropolitan case.

III. Would not effectively purify the effluent.

IV. Offers one of the most feasible means of solving the difficulty.

V. Is not expedient.

VI. Is not to be recommended.

It thus appears that out of all the various plans, the Commissioners only considered two of any value, Nos. II. and IV., and it will be observed that IV. is really II. supplemented by III., therefore their recommendations may be said to be in favour of II. to be supplemented by precipitation. They say that this process, "filtration through land," has great scientific merit, and offers valuable practical advantages for the disposal of sewage "where land suitable for filtration can be obtained"; and they further add, "however it appears desirable, *when the area of the land is reduced considerably*, that the sewage should be previously treated by some efficient process for removing the sludge. For a small number of people, say *under* 500 *to the acre*, the sewage may be applied as it comes, leaving the grosser matters to become amalgamated with the soil; but if the number be increased, the previous removal of the sludge would be desirable; and for 1000 or more, it would probably become absolutely necessary."

The desire of the Commission to reduce the amount of land is explained by reference to other parts of their Report, in which they give as their opinion, that a large quantity of land would "involve great probable cost and powerful opposition;" also, they refer to evidences of popular prejudice, which even if less well grounded than is generally supposed, must not be disregarded.

But let us review the case as it now presents itself to us. There are practically three methods of disposal left for consideration.

I. That by land treatment alone (as is adopted at Paris and Berlin).

II. Precipitation supplemented by land treatment (which may be called the Commission's Scheme).

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III. Precipitation supplemented by chemical treatment (which may be called the Metropolitan Board of Works' Scheme).

Method I., as we have seen above, was considered by the Commission as unadvisable, on account of the quantity of land required and the cost and opposition which would be involved in acquiring it.

Method II. reduces the objections to a land treatment, by adopting a previous treatment, which diminishes the amount of land required to about one-half; but the method recommended of dealing with the sludge is open to very serious objections, as will be pointed out.

Method III., the one which is now just coming into operation, is, as has been before remarked, exciting a great deal of adverse criticism.

In this scheme it is proposed to attempt to purify the liquid by chemical means, a course which was not only condemned by the Commission but by every scientific inquiry that has been held on the subject. The Commission says, "*All Reports* agree that after chemical treatment, a considerable amount of polluting matter must be left in the effluent."

Then as regards the disposal of the sludge, the arrangement proposed (although recommended by the Commission) seems to be open to very grave objections. According to estimates of various authorities, there will be about four thousand tons of solid matter barged and deposited at the mouth of the river daily. Apart from any question of nuisance which may arise from this operation to the coasts in the immediate neighbourhood, there seems to be a great probability of serious interference with the navigation over the bar of the river. The average depth of the estuary between the Nore and Tongue Lights is less than 30 feet below low water, and the effect of depositing 4000 tons daily of solid matter in such a depth, will be to render the navigation there, in a very short time, thoroughly impracticable. This objection can only be obviated by compelling the barges to deposit in not less than 50 feet of water, which can only be obtained by barging to some distance to the eastward of the Tongue Light; thus necessitating a much larger amount of plant in the way of barges, &c., than is being prepared, as each barge will have to make a voyage of about double the distance at present proposed. Taken altogether the proposed method of dealing with the sludge is one to be most strongly condemned.

As regards the experience of other cities, there is no doubt that

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Method I. is the one which has been adopted by most, and certainly by the two next largest cities in the world. Method II. has been used to a considerable extent, but Birmingham is the largest city, as far as we have information, which has adopted a precipitating system: whilst with regard to Method III., the author believes that no precedent on any large scale can be found for it.

Lastly, as regards Cost.—The cost of obtaining land for the treatment of the sewage required in Methods I. and II., was pointed out by both the Commission and the Metropolitan Board of Works (Report 1888), but beyond that no attempt was made to arrive at figures; as regards Method II., the precipitation process was estimated by the Commission to cost about 1*s.* per head (equivalent to an annual outlay of 200,000*l.*), and to this will have to be added the cost of disposing of the sludge.

In the case of Method III., we had some particulars of the Metropolitan Board's estimate of the cost of this in the discussion at the Society of Arts on Sir R. Rawlinson's paper this year, and further information is to be found in the Metropolitan Board's Report of 1888: from these sources we gather that about 1,000,000*l.* is to be spent in plant for precipitation and removing sludge to sea, and the annual cost, including interest on capital, is to be 118,000*l.*

According to this, Method III. appears to be the cheapest, but in a discussion in 1887 at the Inst. C.E., it was pointed out that the sewage, from its varying condition, might require different proportions of chemicals, and hence increase the annual cost, as Colonel Jones suggested, from 20,805*l.* to 268,275*l.*, that is, to over ten times the amount estimated; and if, even then, the effluent is not purified, and complications in regard to the disposal of the sludge arise, and hence, further complaints, more inquiries, and perhaps legal proceedings ensue, this method must turn out in the end to be the most expensive one.

As there are so many grave objections to and uncertainties in the method for disposal of the sewage proposed by the late Metropolitan Board of Works, both in respect of results and cost, the author suggests for consideration that steps should be taken to learn if the difficulties in obtaining such land as is required for Methods I. or II. are so great as has been assumed; and if not, to ascertain by experiments whether these methods, either or both, would not give better results than that proposed by the late Board.

The actual amount of land required to fulfil the conditions of the

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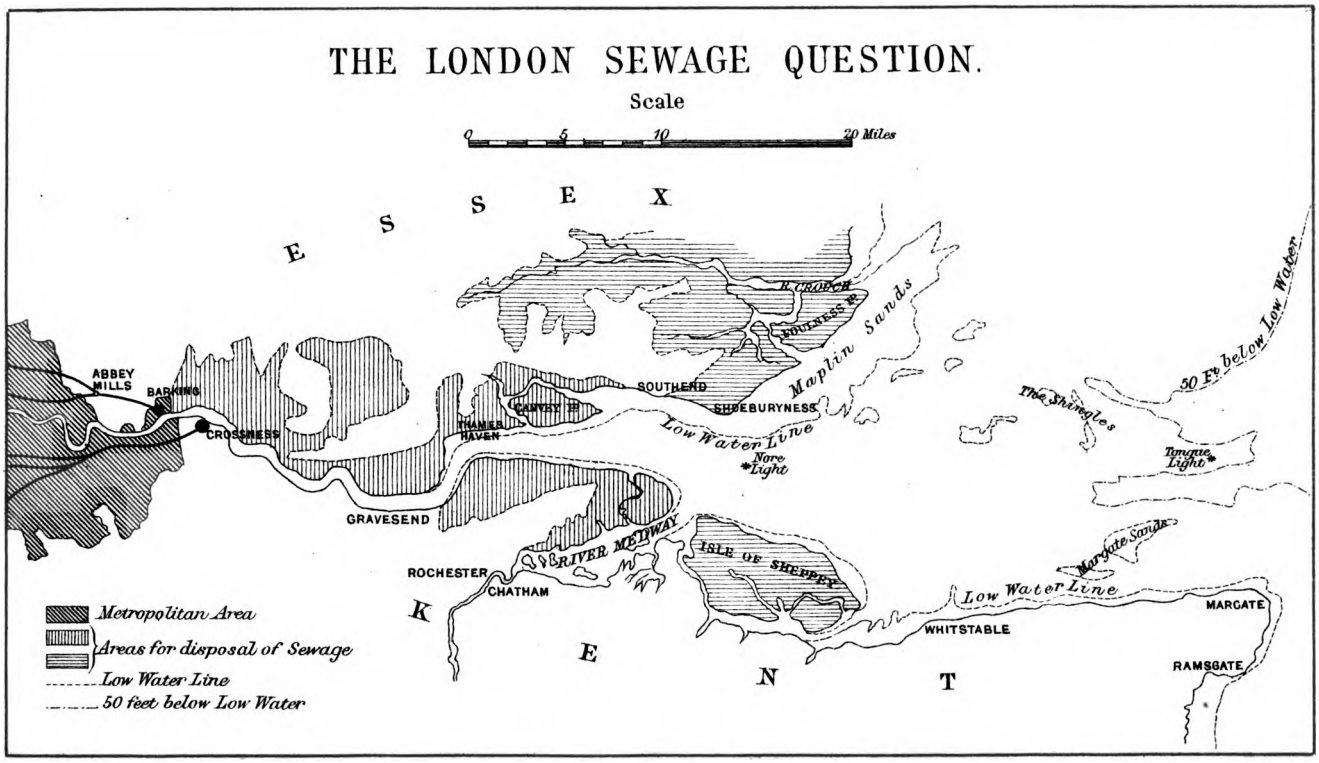

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Commission, namely, that the sewage "of under 500 persons should be dealt with on one acre," would be about 10,000 acres, 5000 on each side of the river.

On each side of the river there is an area, between the 50-feet contour and the river, available for this purpose; that on the north side is over 50,000 acres, and on the south 20,000 acres. The author suggests that the 5000 acres required on each side should be selected within these areas, not necessarily all in one plot, but wherever suitable land could be obtained without difficulty.

There are also other areas further to the eastward which might be brought into requisition in case there was any difficulty in obtaining land on the nearer areas, or as increase of sewage to be dealt with required it.

The author thinks it advisable that the plots on which the sewage would be filtered through the land should be purchased; that besides these, other lands should be leased on which to apply the sewage occasionally on the broad irrigation principle, as suggested by Mr. Bailey Denton before the Commission; and that, in addition, the sewage might be laid on to such farms as would take it in the first place, the probability being that as the benefit of it was experienced the desire for it would increase, as at Gennevilliers.

With regard to the arrangements for pumping the sewage, this might be most conveniently effected on the north side at Abbey Mill pumping station, where the sewage from the high and middle levels would only have to be raised about 30 feet. On the south side it will be a question for investigation whether, as the available land for treatment is over 10 miles away from the outfall, it will be better to continue the outfall for that distance and then pump up the sewage, or to convey the sewage over to the north side and then deal with it. As far as possible the conduits should be laid along the roads.

With regard to any fear of nuisances arising from such arrangements, it is evident that there will be no more at the pumping stations than there are at the present ones, which may be said to be *nil;* nor will there be any more along the line of conduits than there is in the streets of London, under which sewage is daily passing; while lastly, at the plots where the treatment takes place, the experience of Gennevilliers and of Berlin should be sufficient to dispel all fears on that ground; whilst in favour of this arrangement, there is the absolute certainty of the results in the purification of the sewage, there will be no sludge to require treat-

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ment, and lastly, there is some prospect of a return from the produce of the land.

Before finally concluding, there is one other point with regard to the late Metropolitan Board of Works' past policy respecting the sewage question, which a comprehensive consideration of the question requires us to review, and that is, their financial policy.

As was explained by Sir J. Bazalgette, in his paper before the Institution of Civil Engineers in 1865, the original arrangement for defraying the cost of the London main drainage was by raising a loan and levying a rate of 3*d.* in the pound; by so doing, he estimated that the principal and interest would be paid off in forty years. In the meanwhile extra works for relieving the sewers and enlarging the reservoirs at the outfalls have brought up the cost to 6,250,000*l.*, but as the rateable value of the metropolitan area has also increased in a greater ratio than that of the population, the principal and interest of even this increased amount would have been paid off in about the same number of years.

However, in 1869 and 1871 the Metropolitan Board of Works obtained Acts* which enabled them to spread the cost of works over sixty years, and relieved them of the necessity of levying the 3*d.* rate for drainage works.

No doubt this is a perfectly justifiable course in the case of expenditure on works which are not liable to increase with the growth of the population, such as the Thames Embankments, Freeing of Bridges, Parks, &c., but in the case of the drainage works, which must keep pace with the population, it is a question whether the arrangements for extinguishing the loan should not fall more directly on those who make it, especially as in this case the works were only designed for twenty years in advance, and no attempt was made to deal with the question of disposal.

The effect of this policy is, that *now*, while still bearing part of the burden of the cost of the works of 1858, the ratepayers are compelled to face the expenditure involved both in increasing the drainage works to make them efficient for present needs, and in providing for the disposal of the whole amount of sewage.

If the 3*d.* rate had been maintained, the loan for the original and extra works would now have been almost extinguished, and thus the ratepayers would be in a position to embark on fresh expenditure for the present urgent needs without any increase of rate. And it

* See Metropolitan Board of Works Report, 1888.

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is to be demonstrated that the 3*d.* rate is not an extravagant amount to pay for the disposal of the sewage; for let us compare the total annual cost in the case of London with that of other towns where we have the information. Mr. Melliss, in 1876, at the Institute of Civil Engineers, gave the annual cost (including the purchase and preparation of land and the main outfall sewers) of the disposal of sewage in the case of twelve towns in England, and the average of these was 2*s.* 8*d.* Now, taking in the case of London the figures of 1888, when the population was practically 4,300,000, and the rateable value 31,000,000*l.*, the 3*d.* rate on this would give 387,500*l.*, equivalent to 1*s.* 9·6*d.* per head, and adding to this the expenses during that year connected with the sewers, 76,000*l.*,* equivalent to 4·2*d.* per head, we have the total annual expense of dealing with the sewage, including a 3*d.* rate for paying off the loan for the Main Drainage Works, would be 2*s.* 1·3*d. per head per annum,* that is, 23 per cent. less than the average annual cost of the twelve towns referred to.

In conclusion, the author submits for consideration the following suggestions with regard to the London sewage question.

First, as regards Separation.

That it is desirable that a partial separation of rain and spring waters from sewage should be made throughout the whole of the Metropolitan district, so as to provide more accommodation for the sewage proper in the present system of sewers, and thus diminish the amount of liquid which has to be pumped and disposed of, and also lessen the amount of sewage which is at present being discharged in rapidly increasing quantities into the river in the centre of the metropolis during rainy weather.

Second, as regards Disposal.

That, as no chemical treatment has yet been found effective in thoroughly purifying sewage, and as there is great probability of serious complications in regard to the proposal of barging the sludge to the mouth of the Thames, the course proposed by the late Metropolitan Board of Works can only be regarded as experimental, and that as the preponderance of scientific evidence, the

* See Metropolitan Board of Works Report, 1888.

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opinions of the Royal Commission as expressed in their report, and the experience of the two next largest cities, agree that a land treatment is an effective method—investigations coupled with experiments should be made simultaneously with the above, with the view of ascertaining whether a land treatment alone, or precipitation supplemented with land treatment (as recommended by the Commission), would not give better results in disposing of the London sewage.

DISCUSSION.

Lieut.-Colonel JONES, V.C.: I have pleasure in proposing a vote of thanks to the writer of this paper. I thank the author for his succinct and excellent paper on this very wide subject—a subject which has been under discussion for so many years, and the discussions upon which have accumulated to such an enormous degree as to render it very difficult to compress the London sewage question into the limits of a single paper. As I and my partner, Mr. Bailey Denton, C.E., have been very much interested in this subject for the last ten or twelve years, I claim to be allowed to give some slight opinion upon the subject. I may say in the first place, as to the conclusions of the paper, I entirely agree with the author. First, as to separation: I gave evidence before the Royal Commission of 1884, and had the honour of having my evidence quoted in the report given in by the Commissioners, as to the diversion of the roof and street water as much as possible direct into the Thames, which runs through the centre of London, and could receive it by short lengths of pipes laid near the surface of roads, instead of letting that comparatively clean water go into the foul sewers, and be pumped and pumped over and over again, as is now the case all over London. From 1868 to 1882, when at last every engineer in the country agreed that the separate system was the right one, I constantly wrote and spoke in favour of excluding surface and subsoil water from sewers. I would never ride the hobby too far, or pretend to exclude every drop of surface water; but where exclusion is practicable it should be done, as far as possible. I am glad to see that the author insists upon that being done. As regards disposal, I entirely agree with the conclusions arrived at by Mr. Barlow in his paper. Moreover, Sir Henry Roscoe, who was called in by the late Metropolitan Board of Works, really to approve their methods of disposal, cursed them where the Board expected

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to be blessed. He said that "the Metropolitan Board of Works, in attempting to deal with the sewage, had acted on wrong principles from first to last." We may take that for granted, for I believe it is now admitted by every authority on the subject. The County Council have inherited a waste of 1,000,000*l.* in the putting-up of permanent works at Barking and Crossness, which are now admitted to be useless for their real purpose. The County Council find themselves committed to that scheme, and feel bound to give it a trial; although it is well known that the system of barging-out the sludge to sea must inevitably break down. The County Council have called in Sir Benjamin Baker to consult with their new engineer, Mr. Binnie, and are now awaiting their joint report. I was sorry to see, by the report of the meeting of the Council on Tuesday last, that they cannot expect to receive that report until after the recess. Accordingly, the whole work of dealing with the London sewage seems to be postponed for some years. Sir Benjamin Baker, coming fresh to the subject, must take considerable time in the calculations required for his report. I should like to call attention to one spot on that map produced by the writer of the paper out of the lands in Essex, indicated by vertical lines, as the one which I am sure Sir Benjamin Baker and Mr. Binnie will recommend—just as the Royal Commission of 1884, acting on the recommendation of Mr. Bailey Denton and myself, recommended it—that is, the Island of Canvey on the north bank of the Thames. Twenty miles of extension of sewers and 30 feet of pumping is all that is required to take the sewage of London there and deal with it effectually. You have there 5000 acres embanked from the tide, so that it already forms a tank of 5000 acres. You have only got to divide it into smaller tanks by earthen embankments, like that which keeps out the sea. The sludge could lie there, and be buried there for ever, with sand and debris, if necessary. It is easy to observe that these 5000 acres are so isolated from the mainland that nothing in the way of nuisance to neighbouring populations could be feared. The Royal Commission said with us, and everybody who has visited the locality is bound to say that Canvey Island is the picked 5000 acres available for the purpose. Nothing would please me more than to see broad irrigation used over the whole 50,000 acres indicated by lines on Mr. Barlow's map, if it could be done at anything like a moderate cost. With such a gigantic measure as that of dealing with the sewage of London, the cost must of course be a great consideration; and I say, begin at any rate with an

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effectual remedy of present evils by using Canvey Island, which can be had at a reasonable cost.

Mr. EACHUS: I beg to second the resolution that a vote of thanks should be accorded to the author of this paper. I have freely expressed my agreement with the conclusions of the paper, in a discussion some few years back, at the Institution of Civil Engineers. I will confine my remarks to the north side of the river, which is best known to me. It is on the north side there is the bulk of the land available for the purposes of this scheme. I have made some estimates of the value of land for broad irrigation in Essex, and I believe that 40,000 acres of land in that district could be obtained for a little over a million of money. It is not in the purchase of land that the great cost will have to be incurred; it is in the distributing channels which will have to be constructed to distribute the sewage over the land. Roughly, I estimate that the channels required to deal with the sewage of London will cost 4,000,000*l.* Estimating that the land will cost 1,000,000*l.*, and the distribution 4,000,000*l.*, that at 3 per cent. will cost about 150,000*l.* a year. Then comes the question of dealing with the sewage when you have it on the land. I don't think that will cost less than about 10*l.* per annum per acre. That means something like 400,000*l.* in farming. Then to pump the sewage on the land you will have to spend about 40,000*l.* a year. On the other hand, you have a large area of land, costing only 25*l.* an acre, from which, with the assistance of the sewage, you could get considerable crops. From my experience, I believe that an average take of 12*l.* per acre per annum could be realised, and you have got to spend 10*l.* an acre to earn it. Estimating therefore the annual expenditure of 150,000*l.* for capital, 400,000*l.* for farming, and 40,000*l.* for pumping, and deducting the receipts for the crops, we have 600,000*l.* gross annual expenditure, and the gross annual receipts 480,000*l.* The net annual expenditure to the County of London would therefore be about the same as the present expenses are estimated to be, viz. 120,000*l.* I have put that in broad figures, because I think it is always best that figures should be given in connection with every scheme. I don't see why the County Council should be afraid to face an expenditure of five or six millions of money, if they could get a reasonable return for the expenditure, and the knowledge of what has been done at Berlin and Gennevilliers shows that sewage can be dealt with on a very large scale by broad irrigation. If this plan were adopted

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by the County Council of London, they would have a large market close at home so that they could easily get rid of their produce. The line Mr. Mansergh laid down for North London in 1885, from Barking to Southend, followed very nearly the northern boundary of the land coloured on the plan. I do not suggest that the London carrier should run exactly on that line, as instead of one carrier, there should, in my opinion, for distributing the sewage of London, be two or three main carriers, to command the valleys into which the district is divided. There is one objection to the separation of surface water from sewage which was not pointed out in the paper. The surface drainage from some roads is found to be almost like the sewage proper. I think that has been the principal objection to the separate system. I quite agree, however, that the storm water should be intercepted as far as possible; but, instead of taking it straight into the Thames, I would take it by high-level intercepting drains lower down the river. By such means we more closely imitate nature, and the rain is conveyed more slowly into the river, more as nature would have conveyed it if London had not been built upon and sewered throughout.

Mr. C. Jones: I will say just one word. I agree with our friend (Mr. Eachus) that there is very often a multiplicity of figures on one side, and great paucity of figures on another. I am not taken up altogether with the idea of conveying the London sewage down somewhere else, or for increasing irrigation farms to the extent which has been referred to; I have an idea that it is not necessary to go beyond Crossness or Barking. One of the recommendations of the Committee refers to a system which I have carried out for several years, and because I happen to be in a comparatively small place, there is no reason why, a satisfactory conclusion having been arrived at there, it should not be applicable upon a very much larger scale even as regards the City of London. I refer to Recommendation 3 of the Commission—"or burnt." I see no reason why we should not go into that question. I attended the Meeting at the Institute when Mr. Dibdin made some remarks about burning, remarks which I do not hesitate to say were very incorrect and misleading. He gave an estimate which allowed so much for fuel, but it is not necessary to spend one penny in fuel in the burning process. The County Council and the late Metropolitan Board of Works have failed to see that there is in London one means of dealing with the difficulty. There is carted away annually more than two million tons of house refuse, which needs

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only to be properly utilised to render it most valuable. I see no reason why the sewage of London should not be dealt with by the utilization of the refuse of London. I throw out these ideas as a matter for discussion, either now or for a future date, for the question of "burning" will come up before this "burning question" is settled. A great deal has been said as to the sewage of Berlin and Paris. Those who know Paris know that there is no comparison to be made between the sewage of that city and of London. We will not go into the details of that. I question the value which is put upon the land, and although much interested by the statement in the paper which Sir Robert Rawlinson read of the value of agricultural land going up 5*l.*, 10*l.*, 20*l.* and 30*l.* per acre, I should like to ask if there is any illustration that can be given of its going up to anything like such a price? ("Yes.") I do not think so. "Milk," says a writer in *The Globe*, "there is well nigh a famine of milk in London, and why should we not raise milk in sufficient quantities for our population on the land in Essex." Milk at the present time is supplied to London at a price so small that it is hardly worth the producing. It is supplied to London at 1*s.* 3*d.* per barn gallon.

A MEMBER: It will pay the farmer to produce it at 8*d.* per gallon or rather less.

Mr. JONES: What is meant by a barn gallon is 8 quarts, not the 4 quarts of our schooldays, and the fraction of profit which is left upon that, even if you were to multiply it by 2, would not make it worth bringing to London. That is an important business point, that any business man can deal with; and to say that you can make a large profit out of producing milk for London is absurd. I think there is sufficient land at Crossness and at Barking to deal with the whole of the sludge; and I know there is sufficient house refuse, which the authorities do not know what to do with, to give them fuel, and to give a very important reduction in their present coal bill. At the present time there are 200 destructor cells working in England, burning a sufficient amount of refuse to give a thousand horse-power. Two hundred cells may be put upon an acre of land. They have seventy acres at Barking, so there is no difficulty about that. There is no necessity to make a nuisance, and I maintain that it can be done. Dr. Carpenter, in a letter to *The Globe*, said, "Let Lord Rosebery and the County Council take the bull by the horns, and spend the fifteen millions necessary." Surely there is no reason why this question of burning should not be taken up and faced

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properly, to see if there is not a mode by which this stuff can be dealt with without taking it down the river at an enormous cost, even on your own estimates, or spending 15 millions in order to utilise upon sewage farms. I don't agree with those eminent men who talk to us of the silvery Thames. That has been the basis of all the blunders that have been made. You will never make it the silvery Thames; it is idle talk. A river with a floating population equal probably to Brighton and Birkenhead put together, can never be a silver stream. Should that time ever come, the advent of Macaulay's New Zealander will be near at hand, and the glory of London will have departed.

Mr. J. P. Norrington: The suggestion of Mr. Jones that the question of disposing of the sewage of London by burning might receive more consideration, appears to have been passed over by all those who have taken part in this discussion, and by all the advisers of the different London governing bodies; and I think the reason is this,—that most engineers will not consider the suggestion seriously as a means of dealing with so large a question. My impression is that all London surveyors will, in a short time, abandon the idea of burning either dust or sewage, and find other means of dealing with them. There is one matter which has been overlooked in connection with this scheme; I only throw it out as a suggestion, because I have not a very great knowledge of that part of the country. I see at the mouth of the Thames a very large area called the Maplin Sands. Why cannot some portion of this land be reclaimed? We all know the large amount of solid matter carried by sewage, and by embanking the waste land and allowing the solid matter to accumulate, the level of the ground might be raised and the land permanently reclaimed. I like to see schemes of this description accompanied by suggestions for reclamation or utilising waste land, because such methods seem to provide some solid recoupment for the original outlay. The paper has been exceedingly interesting, and the method proposed for dealing with the question is one which appears to me must be ultimately adopted. I cannot think of any better method of dealing with sewage than that of applying it to the land. It seems the most natural, and I believe that which is most natural will finally be found to be the most sanitary, and even the cheapest. With reference to the separate system of drainage referred to in the paper, I may say that our late esteemed friend, and Engineer to the London County Council, Mr. Gordon—I mention his name with a good deal of feeling, for

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rarely have I been affected more deeply than at the sudden manner in which we lost him—as soon as ever he was appointed, wrote to the London Surveyors and asked if, in connection with the sewer plans they submitted to the Council, there was any means of dealing with the surface water separately. That shows the matter had attracted his attention, and I have no doubt that it was his intention to propose some scheme for dealing with the subject. There is a rumour in London that he had commenced a comprehensive report on the sewage of London; and if the rumour be true, everyone must regret very much that this report was never completed. I was rather sorry that in the Minutes read to this meeting there was not more special reference made to the loss of the former President of this Society and the late Engineer to the London County Council.

Mr. SAVAGE: I am assured that the question of the separation of the bulk of the rainfall from the sewage of London is one that must come to the front very soon. At East Ham, adjoining Barking, the northern outfall sewer is charged to the fullest extent during heavy rains, and the last heavy rain we had the sewage reached the top of the manholes. It seems monstrous that so much rainfall should be allowed to pass into the sewers, and have to be pumped up, and perhaps treated, instead of being allowed to flow away by gravitation. It seemed strange that the old outfalls should not have been retained for storm water, as any one could have seen that they would have been of the greatest service.

THE PRESIDENT: I congratulate the author very heartily upon this paper, for one particular reason that he has given every credit to the Engineer, Sir Joseph Bazalgette, who designed the wonderful works for the drainage of London. It has been the fashion for engineers to make unfair attacks upon him for what he did. Many of us can remember what London was before that drainage was carried out, and we see how it is now. The question of drainage has occupied the minds of engineers for a considerable period. I congratulate the author for the clear way in which he has put the different methods for dealing with sewage, and the way in which he has summed up those methods, and practically recommends irrigation. With that irrigation he also recommends separation, and upon that matter there is no doubt the separation of foul water from the water which falls upon the roofs and courtyards is a very important matter. I think it was Mr. Jones who said that the water still flowing into the Thames would be foul,

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but the amount of impurity is so small that it would amount to nothing. The first fall of water on the streets and roofs carries impurity with it, but that soon passes away. Every engineer thinks favourably of the separate system. With that separate system, and some other means of disposal of the sewage, though we shall not reach the Utopian idea of the silvery Thames again, it might be improved. Mr. Jones has naturally spoken to us of his idea of burning the sludge, and there is no doubt, as any one who has visited Mr. Jones's works at Ealing can imagine, that it is possible to increase that system to such an extent even as to destroy the sludge of London. It is, however, a very big question that we cannot deal with at present, and it would require a paper in itself. In page 164, the author mentions a threepenny rate, and then passes on to say Mr. Melliss gave the cost of twelve towns, and the cost there was 2*s.* 8*d.* I think it should be put in that 2*s.* 8*d.* *per head* is meant, and not a 2*s.* 8*d.* rate.

The vote of thanks having been unanimously accorded,

Mr. BARLOW, in acknowledgment, said: I think the few kindly criticisms which have been made leave nothing for me to answer, and I thank you very much for the gracious vote which you have accorded to me for the paper. Mr. Jones' scheme for the burning of the sludge involves the separation by chemical means of sludge from the sewage, which is a thing to be avoided. With regard to the production of milk, other things may be grown on the land; for instance, strawberries are grown on sewage farms.

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MAINTENANCE OF MAIN ROADS AND COUNTY MANAGEMENT.

By E. PURNELL HOOLEY, Assoc. M. Inst. C.E.,
County Surveyor of Nottinghamshire.

The question of main roads and their maintenance, at the present time, is of the greatest interest and importance to a County Council and the various authorities in a county. It is with the idea of opening the vexed question of systems for main road maintenance for discussion, that the writer has undertaken to give his experience, in the hope that a system that works so far satisfactorily in one county may be shown to others, not in a dictatorial spirit, but in the invariable spirit that all matters are brought before our Association, mutual help and the good of our respective authorities.

Many papers have been written on methods of road making, repair, and consequent expenses; but the Local Government Act of 1888 has placed the large question of payment of expenses on a very different footing, causing varying results in different counties, and it is to this question the writer will first direct your attention.

The Local Government Act was framed principally with the hope of helping and reducing local taxation, and placing the power of county government in the hands of elected representatives instead of the then county governing power, the Justices in Quarter Sessions. Of the latter body no one would wish to say a word in condemnation, as far as their power and efficiency relates: all will agree that a better or a more painstaking body of gentlemen never will be found, and no Local Government Act could ever be satisfactorily carried out without that which has been so freely given, their loyal assistance and ready help. But their power was not sufficient, and the Local Government Act 1888, the writer thinks, was greatly the result of the magistrates' own wishes for more power to be placed in the hands of the county authority.

After the question of composition of the County Councils, the next important alteration, at any rate from a surveyors' point of

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view, is the position of the present urban authorities to the County Council.

Sub-section 2, section 11, of the Local Government Act 1888, provides that any urban authority may claim to retain the powers and duties of maintaining and repairing a main road within the district of such authority, and the council shall make to such an authority an annual payment towards the cost, &c.

I think, so far, this clause has caused more trouble than all the rest of the Act, but I fail to see why it should do so.

By the 1888 Act, the duty of repairing the main roads falls on the County Council, but any urban authority may claim to retain its own main roads, and by so doing a very large amount of extra work is taken from the county authority. If the urban authority had not claimed to retain its own main road, the Council would have had to carry out exactly the same work, or have required the urban authority under sub-section 4, section 11, to have done so. As this is the case, I cannot see any difficulty of settling any payment; whatever the main road requires for its efficient maintenance should be paid in full by the council, and to this end I think any payment made by averages most unsuitable and unreasonable. The roads have to be maintained to the satisfaction of the County Council, and it is unreasonable to any practical man to say, "Your roads in the past three, five, or seven years have cost so much; next year the cost shall be exactly the same," in spite, very probably, of a bad season and greatly increased traffic. If roads have to be repaired year after year for exactly the same sum, with decreasing traffic, the average payment is unfair to the county authority. If exactly the same sum is allowed with an increasing traffic, and consequent increasing expenditure, the average payment is unfair to the urban authority, for it has to pay the extra sum out of the district rates on main road maintenance, to keep the main roads in a good state of repair to the satisfaction of the County Council. The "average" as a basis for expenditure, can, the writer thinks, never have been more wrongfully placed than in one district of his knowledge. A former surveyor saved, by lessening the cost of maintenance, i.e. starving the road of materials, &c., until in places the actual foundation came to the surface; this was promptly taken up and broken as metalling by the then surveyor; as the result, the main roads that required at least two hundred tons of new material a mile, never had more than thirty tons used, and then only to fill up the deepest and most dangerous ruts. To

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remedy the mischief, the surveyor persuaded the local authority to "make up" the roads before the Local Government Act 1888 came into force; they did so, and the cost went up from 38*l.* per mile, under the "saving system," and 130*l.* in patching afterwards on certain roads, to 230*l.* per mile; but as each road was finished a benefit was felt, and a still greater benefit was felt last year. Under the old county system and Government grant, the local authority received back 75 per cent. of its actual expenditure. Then came the County Council, with a new system of payment on an average of the last three years' basis. The year's estimate, making full allowances for all incidental expenses, was 3393*l.*; the average of the three previous years, owing to the large amount of extra work done, 5386*l.*; so the county authority, having no contract stating what should be done for the 5386*l.*, actually paid 2000*l.* towards the district fund over the amount estimated, and proved a very welcome relief to the direct ratepayers of the district.

The writer's idea for adjusting this question is the system adopted this year, and for future years, in the county of Nottinghamshire; let the main roads in urban districts be repaired by the urban authority under contract, for a sum to be agreed on beforehand, and a regular form of contract, with specification, &c., entered into. To carry this out satisfactorily the county surveyor and the urban surveyor will first go over and inspect the roads, mutually agreeing as to the amount of material required on each special length of road, and every other kind of work connected therewith. When the total amount is settled the urban authority will tender to the county authority to repair the main roads in its district for a stated sum, in the manner laid down in the contract, and should the amount of material, &c., agreed upon afterwards be found insufficient to satisfactorily carry out the contract, the urban authority will apply to the county authority, and any extras the county authority may consider necessary will be allowed and paid for as extras by the county authority, exactly as though the County Council did their own work. By this system no payment need be made out of the district fund for main road maintenance. Under the "average" system it is almost bound to be so, and is grossly unfair, the Local Government Act being framed to assist local taxation. Under the "average" system it is possible to obtain from the county authority a payment on account towards the amount spent, often months after the money has been spent; under

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the contract system, payment is made at the quarterly meetings of the county authority of the actual expenditure.

Simply, the system the writer has advocated is, the payment of all charges in connection with main roads by the county authority, as far as practicable, direct; no profit or loss to be chanced by either side, and, whatever the county authority would have to expend to maintain the roads, if they were in their own hands, shall be expended by the urban authority and paid for by the county authority, the contract setting forth what shall be done, so there can be no question afterwards as to what is the satisfaction of the County Council or county surveyor, compliance with the terms of the contract covering all and securing both sides.

To bring this contract to a favourable result, the writer attended all the urban authorities and highway board meetings within the county and explained the whole matter to each, with the result that every authority accepted the contract form, and it is now in operation.

Another very strong point in favour of the specification and contract system is the security that a proper amount of materials every year is used on the road. Often by small authorities it is considered good and legitimate business to save material and day labour year by year; never mind the final result, save all that is possible this year, and the same story is told next year, in spite of the surveyor's advice otherwise, until often a road is reduced to a bare covering over its foundation, and then the "saving" tells its own tale by costing more than double the amount saved to get the road up into condition again.

As to the county managing main roads, the writer is of opinion the County Council should most certainly directly manage all roads that have been hitherto managed by highway boards and parishes, and for the system now in force in Nottinghamshire the writer thinks a portion of a report he wrote to the highway committee of his council will fully explain the chief ideas and give a general notion of how his county is now managed, for the report was adopted in its entirety, and the system is now in force.

The county of Nottingham has hitherto been managed in rural districts by four highway boards and ninety parishes managing their own highway matters, the total number of miles being:—

	Miles.	Fur.
Under Highway Boards	120	4
„ Urban Authorities	54	0
„ Parish Management	146	7

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The latter are now under the direct control of the County Council, and next year the highway boards will be also. The total expenditure last year was as follows:—

	£	s.	d.
Highway Boards	5242	0	0
Urban Authorities	4098	0	0
Parish Management	6330	0	0

The two former have been increased by about 3500*l.* this year, because the County Council are now paying for everything in connection with the main roads, and there will be that much saved to the local authorities. The parish management will cost about the same, but a very great amount of extra work will be done for the same money.

COPY OF A PORTION OF A REPORT OF THE SYSTEM PROPOSED FOR PARISHES NOT UNDER HIGHWAY BOARDS, TO BE EXTENDED TO THE LATTER AT A LATER DATE, IN THE COUNTY OF NOTTINGHAMSHIRE.

The idea will be to apply the same system of application of materials to the roads, as set forth in the contract for existing authorities, and to this end the following suggestions are offered for the approval of your committee and council.

Manual Labour.

In purely rural portions of the main road (i.e. on portions similar to that between Worksop and Carlton), one man will be required on each three miles, all the year round; one man on each two miles on roads partly urban and partly rural (i. e. on portions similar to that between South Collingham and Newark); and one man on each mile and a half of road quite urban, such as through the villages of North and South Collingham. On such roads as Kingston and Gotham, in the neighbourhood of plaster pits and collieries, of course, this would have to be varied; a great deal more labour would be required. Tuxford, a purely agricultural portion, on the other side, would require less. It is next to impossible to exactly gauge the number of ordinary labourers required, but a very short experience of actual management is the best guide to this and many other works. The wages of these men should vary from 12*s.* to 18*s.* per week. Each labourer should be supplied by the foreman with a sheet, stating the work he is to do each day, such sheet to be produced when required to be initialled by a member of

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the council, by the surveyor or foreman (chief), and would take all orders and directions from the foremen.

Foremen.

The best of the existing road-men in the parishes could be engaged for this work. They should have about twelve miles of ordinary road to superintend, varying, of course, very much with the present state of the road and traffic of the future, but should live in the centre of their length. Doubtless, more foremen and labourers will be required at first than later; but take a road thirty miles in length as the work became less, and the road in better condition, the worst foremen and labourers could be discharged, and the district of the others extended.

Each foreman should supply himself with a sheet, stating the work he is engaged upon. Such sheet to be produced when required to be initialled by a member of the council, by the surveyor or chief foreman. The foremen should keep the time sheets of themselves and men under them; be accountable for all tools, and for the condition of their road-length; receive and check all material, entering same in their account book; take all necessary orders from the chief foreman of the district; and see the whole of the work properly carried out, working themselves. The wages for these men should vary from nineteen to twenty-two shillings per week, and their ages should be between thirty and forty-five years. They should have no power to discharge or engage any workmen without first reporting the matter to the chief foreman. They shall keep all tool, team, and materials accounts of their divisions.

Chief Foremen.

I think, at commencing the direct management of the roads, if the whole of the urban authorities and highway boards retain their own management, three chief foremen will be required. Generally, one foreman should take the Great North Road, and all roads east and north of the same, residing at Retford, a road area of about 120 miles. One foreman should take the Nottingham and Newark Road, viâ Southwell, and all roads south, including the Nottingham Highway Board, and roads up to Sutton-in-Ashfield, residing at Nottingham, a road area of about 100 miles. One foreman should take the road from Oldcoates to Barnby, from the

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latter to Newark, and from Newark north of Sutton, including all that division of the county, consisting very largely of small local authorities, &c.; a road area of about 100 miles. He should reside at Worksop.

Their duties should be to superintend the entire road management direct from the county surveyor. They should have no power to discharge or engage any foreman without first reporting the matter to the county surveyor, but should have full power over the day labourers. They should take all moneys from the county surveyor, for paying the foremen and roadmen fortnightly, and pay them direct, entering same in a book provided for the purpose, and get a receipt from the men on the labour sheet, to balance with the foremen's account. They should set out and direct all work for manual labour. They should check and superintend the delivery of all material under the material contracts. They should arrange and order, on check forms, all horse labour that may be required under the team labour contracts, and see the same is properly employed and entered in the road foreman's book. They should collect all accounts that might be owing by the council for road maintenance. They should, under no pretence whatever, order any new tools, materials, or special work, unless the order is signed by the county surveyor; in cases to avert an accident, or to save expense, alone excepted. They should walk the district under their charge, as far as practicable, and carefully take and keep notes of works required to be done. They should assist the county surveyor in every way, in estimating for material, team, and manual labour, and any other work.

Where main roads are repaired by contract under any highway or urban authority, they should walk over same, not interfering in any way with the management, but reporting any matter that should require reporting to the county surveyor. They should initial the sheets of the foremen and day labourers of the Council, when passing at any time other than when paying the wages, collecting such sheets when paid, and returning the sheets and the duplicate pay-book of the foreman to the county surveyor. They should be guaranteed in the sum of 50*l.* through a guarantee society (the Council paying the premium), for the honest performance of their duty. They should be paid the sum of 35*s.* per week, rising annually to 2*l.*, with an allowance of 10*s.* per week for general travelling expenses. They should work the same hours as the workmen, and do their utmost to skilfully manage and check

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all extravagance on the roads, filling up any spare time in doing any necessary road work. Should any foreman be temporarily laid up, the chief foreman should take his place in every way until fresh arrangements can be made. They should keep an order, tool account, material, team, and general expenditure book; also a careful diary of their day's doings, and should every year, or as often as necessary, take stock and furnish the county surveyor with a return of stock and tools in their district.

The steam roller should be under the full direction and charge of the chief foreman, and he should pay special attention to the economical working of same.

The chief foreman and the foremen should be provided by the Council with overalls and oilskins, so that they may be on the roads during wet weather, and be able to deal at once with any matters that may only show the work necessary in such weather.

Tools.

Every foreman should be furnished with the following tools, for the use of the men under him, and himself:—

4 shovels.	3 pickaxes.	4 rakes.
3 spades.	2 hooks.	4 road lines.
6 brushes.	2 sledges.	4 scrapers.
3 wheelbarrows.	4 small hammers.	

The tools should be repaired by contract on a schedule; each blacksmith should tender every three years, or as often as might be required; and before any tools are repaired, the foreman should give a written order to the smith and preserve a duplicate himself.

Team Labour and Materials.

All team labour and materials should be let by tender and contract. No material should be received unless previously invoiced, with twenty-four hours' notice, the total weight of each truck to be sent and the railway weight to exactly correspond, for the latter would be taken as correct. If the material be delivered by road, it should be weighed (if possible at a public weighing machine), and the exact weight of the material sent, with the carter's signature attached. All weight checks should be delivered to the road foreman at time of unloading, either by the railway company, contractors for material, or the carters, on proper forms.

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Accounts.

Accounts of all kinds should be sent to the county surveyor direct, as soon as the work or contract is complete, and no account would under any circumstances be passed, unless accompanied by the necessary order for the work being carried out. Accounts for tools should be sent to the county surveyor, at least one month before the meeting of the County Council.

County Surveyor.

He would take the direct management of all the roads now under the various parish managements, setting out all work to the chief foremen, continually drive over the whole of the main roads of the county, and superintend the carrying out, so far as possible, his own instructions; prepare estimates for material, team labour, and money payments, advertise for and receive all tenders for work, and lay same before the Highways Committee; keep all accounts, and prepare the necessary balance sheets.

This portion of County Council work being entirely new, and entailing endless work, I think it will be necessary to ask the Council for some assistance in the surveyor's office. I therefore beg to suggest one writing clerk and one draughtsman, to assist in carrying out the work thus proposed.

In concluding my report, I have to acknowledge the kindly assistance I have received from each surveyor, and others with whom I have been brought into contact, and hope my report will prove useful. I have tried my utmost to prepare a scheme of management that I think could be well, economically, and beneficially adopted, in the interest of the County Council of Notts, the present existing authorities, and the ratepayers generally. There are very many minor matters that will require careful consideration, but as a general scheme I am in hopes your Committee will approve of it; I think it is practical, and I am sure it is unique.

If there is any other matter the members of our Association would like information on, or would like to see any copies of our forms, the writer will be at all times pleased to show any that he has power so to do; and trusts if his paper has not been too long to be of interest, it will serve its original purpose, and bring the new position of urban and county relations before our Association for discussion, and mutual help will be the result.

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NOTTINGHAMSHIRE COUNTY COUNCIL.

CONTRACT for repair of the Main Roads under the for the period of one year from March 31st, 189 to March 31st, 189 .
Total mileage, .
To whom payment is to be made .
Date 189 .

COUNTY COUNCIL OF NOTTINGHAMSHIRE.

SPECIFICATION for the Repair and Maintenance of the Main Roads under the .

Name and Length of Road.	Name and Length of Divisions.	Materials to be used for Repair.	Quantity.		If Footpathed, to be repaired with.	Quantity.	
			Tons.	Tons.		Tons.	Tons.

CARRIAGE ROAD.

The whole surface to be swept or scraped as often as required, and on no account shall the road, under any condition, be left for more than eighteen hours (Sunday, Good Friday, and Christmas Day alone excepted) after rain or bad weather, without being carefully attended to. The scrapings, &c., when not wanted to repair the footpaths or for filling hollows in the roadside, or stone depôts, must be carted away when dry, and on no account to be heaped and left on the roadside. The water-table at the roadside or side channels to be lined with material if soft or too low, and any clay or other matter which may prevent this being properly done shall be taken out and carted away, and the road filled and rammed with large stone. The channels shall be frequently inspected, and kept clear of all obstructions, the whole being carefully sided, and outlets cut open at least twice during the twelve months. After rain the sand drifts shall be at once removed, and no weeds, &c., shall be allowed to grow in the side channels, so as to interrupt the free

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passage of the storm water. The material shall be applied to the road carefully, evenly, and smoothly, and frequently raked over, to prevent all tracking until the whole becomes one solid mass; the road, before any material shall be applied, being first swept and cleansed free of mud. Where the road is flat, care shall be taken and material allowed to raise the same to the gauge mentioned hereafter. Where the road shows soft, weak portions, the latter shall be removed, and the road made sound by means of ramming in large stones. Where the road shall require the ruts filling, care shall be taken to keep the filled-in ruts properly filled with material, so as not to allow other ruts to form at the sides; but no ruts shall be allowed to form after those already on the roads are carefully mended. Any loose stone on the road between the 1st of April and the 30th of September shall be at once picked off. If the road should be blocked with snow, so as to impede traffic, the local authority shall forthwith remove the snow, informing the county surveyor of same, and the cost will be paid according to scale of charges appended herewith.

Gauge. As far as practicable, all roads shall be formed with a fall of one-quarter inch to a foot from the centre to either side.

Drainage. The cross drains, gutters, culverts, and other surface-water carriers shall be kept in good repair, and free from obstructions; where ditches are above the level of the road, the local authority shall see they are properly lowered and cleaned out.

Watering. During the summer, water-carts shall be employed watering through urban districts at the rate specified in the attached schedule.

Steam rolling. All material shall be consolidated if possible by the use of a steam roller, and where same is hired for use, it shall be paid for at the rate shown on the attached schedule. Where new material is consolidated with a steam roller, it shall be applied thus: first the edges shall be cross scored from the centre to the sides at an angle of 45°; then the new material shall be applied, not more than two stones thick, rolled, and consolidated, the surface evenly rolled, and, if found necessary, a very slight binding material applied, carefully swept and watered; finally, rolled in, and all superfluous water and dirt swept off. The roller shall consolidate at least 1400 square yards of new road surface in one day of ten hours.

Footpaths.

Where footpaths already exist, they shall be swept, cleansed, and attended to generally, as often as may be required, and such portions as are maintained in any other way than by tar paving shall be kept up to an even and proper contour. The repair of existing, and making metalled footpaths into tar-paved footpaths shall be paid for at per yard run, according to scale of charges appended herewith, and not included in the total contract. Before any new footpath shall be made, application shall first be made to the County Council, and their consent obtained, before any expenditure shall take place.

Gauge. As far as practicable all footpaths shall be formed with a fall of one quarter inch in 18 inches from either side towards the road.

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ROAD BETWEEN HEDGE AND HEDGE.

The local authority shall see and undertake that all thistles, weeds, and nettles on the roadside turf shall be cut down to prevent seeding. Weeds.

The local authority shall serve the necessary notices and keep all hedges and trees properly lopped and trimmed, according to the requirement of the Highway Act. Should any prosecution occur to enforce the order of the local authority, the County Council will assist in every way, and pay the necessary costs, first having the same taxed if they think necessary. Hedges and trees.

The whole of the materials used shall be subject to the approval of the County Council and their surveyor, and the quantity and quality shall be according to the schedule appended herewith; should any extra material be required, it shall be purchased and paid for by the local authority, first having obtained the consent and approval of the County Council and their surveyor in writing, according to the price attached to the schedule herewith. The whole of the materials shall be drawn to the roadside or into the stone depôts between May 1st and September 29th, 1890, being ready by the latter date for application to the road surface. No material shall, under any pretence whatever, after being drawn to the main road, be removed to any other road or to any other portion of the main road than where contracted for, except by special permission in writing from the county surveyor; should any of the material be drawn to the main road or depôts and not used, it shall be paid for by, and remain the property of, the County Council. No stone shall be used other than of the gauges shown on the schedule attached. Materials.

Upon the production of the railway, canal, or carters' receipts for material, the County Council will pay the amounts expended, at their October meeting, and will pay 25 per cent. of the amount contracted for manual and team labour. No payment will be made for material that is not on the roadside or in the stone depôts by October. The remaining 75 per cent. of the actual contract will be equally paid at the January and April meetings, subject always that the roads be repaired to the satisfaction of the County Council and their surveyor. Payments.

In case of any dispute, the matter shall be referred to an arbitrator to be mutually agreed upon, and the payment of the cost of such arbitration shall be at the discretion of the arbitrator. Disputes.

The local authority shall furnish the County Council surveyor with the particulars of road divisions, lengths, and other reasonable particulars he may require, and shall carefully fill in the prices of particulars, so that correct payment may be made for any extras. Particulars.

The signed contract shall include the whole of the cost of repairs for the twelve months, with the exception of actual new footpath forming or converting existing macadamised into a tar-paved or other made footpath. Contract.

This signed contract shall not in any way interfere with the present right or prestige of any local or urban authority, but shall relate entirely to the management of the road and footpath surface.

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SCHEDULE OF CHARGES upon which this Contract is based, and upon which any extra payment may be made.

N.B.—Prices of all materials under this Schedule for extras to include team labour, breaking, and spreading on road surface.

Name of Road,

	No. of Tons.		Gauge.	Price per Ton.	
Carriage Road—					
Granite					
Cinders					
Boulders					
Other material					
Footpaths—					
Chippings, granite					
„ cinders					
Ashes					
		Width.		Price per yard run.	
Tar paving					
Other made paving					
Draining, kerbing, or forming for same					

		Weight.	Price per Day.	
Roller—				
Whether hired				
Who from				
the property of Authority ..				

		To hold Gallons.	Price per Day.	
Water Carts—				
Whether hired				
Who from				
If the property of Authority ..				

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SCHEDULE OF CHARGES, &c.—(*continued.*)

		Price per Day.
Snow Removal—		
Removal of snow in carts ..		
Use of snow-plough and horses		

SPECIAL SCHEDULE.

(To be included in Contract Total.)

	For Twelve Months.
Establishment Charges—	
Clerk's salary, &c.	£
Surveyor's salary, &c.	
Various expenses to be stated and priced in full	

FORM OF TENDER.

To the County Council of Nottinghamshire.

I, the undersigned, , on behalf of the [Local Board] or [Highway Board], do hereby tender for the repair and maintenance of the main roads, and the footpaths co-extensive with such main roads, within the district of the said , from the 31st day of March, 189 , to the 31st day of March, 189 , subject to the conditions contained in the annexed specification and schedule, for the sum of , subject to any agreed additions or subtractions that may be afterwards found necessary, such additions or subtractions in no way invalidating the contract, but shall be dealt with as specified according to the specification and schedule hereto annexed.

Dated this day of , 189 .

Signed_____

Witness_____

The amount, £ , is made up as follows:—

	£	s.	d.
Materials			
Team labour			
Manual labour			
Establishment charges			
	£		

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FORM OF CONTRACT.

We, the [Local Board] or [Highway Board] do hereby agree with the County Council of Nottinghamshire to repair and maintain main roads within the district of the said [Local Board] or [Highway Board], and the footpaths co-extensive with such main roads, from the 31st day of March, 189 , to the 31st day of March, 189 , subject to the conditions contained in the annexed specification and schedule, for the sum of , subject to any agreed additions or subtractions that may hereafter be found necessary for the due performance of this contract, and efficiently carrying out the repair and maintenance of the said main roads and footpaths, such additions or subtractions in no way invalidating this contract, but shall be dealt with as mentioned in the specification and schedule hereto annexed.

IN WITNESS whereof the said County Council of Nottinghamshire and the said Board have hereunto affixed their Common Seal the day and year hereinafter written.

The Common Seal of the County Council of Nottinghamshire was affixed this day of , 189 , in pursuance of a resolution passed at a meeting of the said Council, duly held on the day of , 189 , in the presence of

Chairman.

The Common Seal of the Board was affixed at a meeting of the said Board, duly held on the day of , 189 , in pursuance of a resolution passed at such meeting, in the presence of

Chairman.

Clerk.

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HORNSEY LOCAL BOARD.

Re Main Roads.

Copy Opinion of Mr. ALEXANDER MACMORRAN, Barrister-at-Law.

The Local Government Act 1888, section 11, (1) imposed upon the County Council the duty and liability of maintaining, repairing, and improving all main roads at their own cost and expense. But section 11, (2) contains a proviso to this enactment. It provides that an urban authority may claim to retain their powers and duties of maintaining and repairing main roads, and in such case the County Council are to make them an annual payment "towards the costs of the maintenance and repair and reasonable improvement" of the roads. By sub-section (3) the amount of such annual payment, if not agreed upon, is to be determined by arbitration of the Local Government Board. The Middlesex County Council appear to have adopted an interpretation of these provisions founded upon the use of the word "towards" to this effect, that they are not under any circumstances liable to pay to an urban authority the full amount of the costs of maintaining, repairing, and improving main roads. I do not consider this to be the true construction of the section. The intention of the Legislature was to transfer to the County Council the entire burden of maintaining main roads, and if they maintain them by their own staff, they must bear the entire expense. The proviso which enables an urban authority to retain the duty of repair was not intended to alter, and does not in my opinion alter, the ultimate liability of the County Council to bear the entire expense. But as in such a case the urban authority would spend, while the County Council would have to pay, it was necessary to place some check upon the former, and accordingly the Legislature has provided that the urban authority shall not necessarily be entitled to all they may spend, but they shall receive a payment towards what they spend, the amount of that payment to be determined by arbitration in case of difference. I am of opinion that the principle upon which that amount should be determined is that the urban

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authority are *primâ facie* entitled to the entire cost of maintenance, repair, and reasonable improvement, but that the County Council would be justified in refusing to pay, and the arbitrator would be justified in disallowing, any expenditure which was extravagant, unnecessary, or unreasonable. And I consider that the contention of the County Council that it is for them to say whether they shall grant nineteen-twentieths or one-twentieth is wholly untenable.

The resolution of the County Council is also, in my opinion, unreasonable, in that it does not really offer nineteen-twentieths of the sum actually expended, but only that proportion if it does not exceed the county surveyor's estimate, which may or may not be a correct estimate; I do not see why the Local Board should take the risk of this.

In any case I strongly advise the Local Board not to accept any agreement like that of last year, under which they are to receive all or part of the sum which the county surveyor shall certify to have been expended. The Local Board should not place themselves at the mercy of the county surveyor to this extent and preclude themselves from going behind his certificate if they think fit so to do.

I think that the Local Board should first of all obtain a copy of the proposed form of agreement. Until then they are hardly in a position to say definitely whether they should accept or reject it. They are, in my opinion, entitled to the entire cost of maintenance, repair, and reasonable improvement of their main roads, subject to arbitration in case of dispute, as already stated. And they should as far as possible avoid accepting the certificate of the county surveyor as conclusive of the sum payable to them.

ALEX. MACMORRAN.

2, ELM COURT, TEMPLE, E.C.,
16*th July*, 1890.

I ought to have mentioned that the recent decision in Warminster Local Board *v.* Wilts County Council, 54 J. P. 375, though not actually in point, bears out the construction which I place upon the Act.—A. M.

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DISCUSSION.

Mr. W. Brooke: Just at this time this is a paper which is of very great interest to the members of this Association. In looking over the paper, there are one or two points which struck me as requiring explanation, and upon which I should like a little further information. I notice that the main roads of the urban authorities in Nottinghamshire are put down in this paper as costing 4098*l.* for a total mileage of 54 miles, which appears to me to be a very small charge, being in fact something less than 76*l.* per mile. Does this include the repair of footpaths? the duty of maintaining which I understand, on reading the Act, should, as well as that of keeping in repair the carriageways, devolve upon the county authorities. At present main roads in my district (Richmond, Surrey), cost something like 1200*l.* a mile, and that too, without the footpaths, which are mostly paved with York flags, with flat granite kerb and channel. As the main roads form the principal streets of the town, the traffic is therefore very heavy. Referring again to the paper, the main roads in the urban authorities' districts are maintained at 76*l.* per mile. I should like to know if the author includes the footpaths in that very small amount. If a road in my district will cost 1200*l.* per mile for the roadway alone, I cannot understand how any urban main roads are to be done at 76*l.* per mile. There has been a good deal of discussion as to whether or not the footpaths in a main road should be maintained at the expense of the county authorities. The Surrey County Council decline to pay for the repair of footpaths, and this matter is, I believe, a bone of contention in several other counties, although in my opinion, as before stated, the footpaths should be included in the cost of repairing main roads. With regard to the subject of keeping in repair the county roads, we have in my district (Richmond), entered into a contract to repair the main roads on the system of taking the average cost during three years. I agree with the author of the paper that it is not a fair system. With heavy traffic, such as I am now having over my roads during the execution of the Richmond main drainage scheme, when hundreds of contractors' carts are daily passing over them, the roads require much more spent upon them to keep them in proper order than during ordinary traffic, and for that reason I consider the average system an unfair one, as the county should pay the actual expenses of repairing the roads as well as the footpaths, which I consider form part of the main highway. In conclusion,

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I have very great pleasure in moving a vote of thanks to Mr. Hooley for his very useful and valuable paper on "Main Roads."

Mr. J. LOBLEY: This question of main roads has occupied our attention for a good many years. I dare say there are some members present who will remember a paper I read at the Annual Meeting at Leeds, in May 1880, on the Highways and Locomotives Act, 1878. Soon afterwards, that Act brought forth some startling facts. The highway authority had to keep separate accounts showing the exact cost of the roads, and the county contributed one-half of the cost. Subsequently, the Government contributed a further one-fourth of the expense, and the local authority then received 75 per cent. of the cost of main roads. There is no doubt that system worked better than the system of averages. In my own county of Staffordshire there was little doubt the policy of putting half the cost of the disturnpiked roads on the county was advocated for the purpose of affording assistance to the rural districts at the expense of the towns; but, to the disappointment of many, it often happened that the towns received a greater benefit from the county than the amount of the county rate they contributed. Then we come to the late Act, which puts the whole cost of main roads on the county, and the trouble which has arisen over the meaning of the word "towards." The Act says, "The county shall make an annual payment towards the cost of main roads," it does not say that it shall pay the whole cost. The County Council may take advantage of that word "towards," to say they are not to incur the whole liability of maintaining the roads. I speak myself quite disinterestedly, because as Hanley is a county borough we are not interested in this question like the non-county boroughs. Between 1878 and 1888, Hanley became a Quarter Sessions borough, and it ceased to get its half cost from the county. I will mention to you one fact to show the curious effect of averages. When we received our one-fourth contribution from the Exchequer, they would not give us the amount calculated on the actual cost of the roads, but on the estimated cost of them as turnpike roads. The contribution, therefore, excluded everything except such work as the old turnpike trusts used to do. Thus the grant excluded footpaths, channelling, watering, and improvements, and there was little allowance for scavenging; consequently our grant was a very small one, compared with our length of main roads, and it remained a fixed amount until the 1888 Act altered things. The taking over of all main roads in country highway districts and parishes by the county, is a step in

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the right direction, but to take over the roads of towns having a population of 16,000 or more is a step in the wrong direction. It introduces the bad system of dual control—the one authority spending, and the other authority paying the money. It would be far better for the Government to give directly to all such authorities assistance from the Probate Duty Grant to maintain their own roads. The liability of the county to maintain footpaths has been settled in a court of law, in the Warminster *v.* Wiltshire case, but we may take it for granted that this law will be altered, because it is rather an anomaly for towns of this class to expect the county to pave their footpaths for them. No advantage is gained by such work being done by the county. The county rates must necessarily be higher, and each town will always be struggling to get what it considers its proper share of such work. On the other hand if all such work is excluded, each town maintains its own footpaths, &c., to its own liking out of its own rates. Mr. Hooley is to be specially thanked for bringing the subject forward at the present time; and I have much pleasure in seconding the vote of thanks.

Mr. J. P. Norrington: The question of the maintenance of main roads has taken a good deal of my attention, and twelve months ago I prepared a report on the subject, believing that the County Council of London were going to relieve the vestries of some of the cost of their maintenance. I regret to say that this expectation has proved futile, as the Council have declined to accept the responsibilities thrown on them by the Act. The previous speaker has referred to the word "towards" in sub-section 2, and I wish to point out in reference to it that if a County Council take over a main road under sub-section 1, it has to be "wholly maintained" by the Council, and it is not reasonable that a local authority should suffer because it prefers to retain control of the roads, especially as the local authority can maintain them more economically than the Council, and the Council are saved a great deal of supervision and trouble. If any County Council has taken advantage of that word "towards," to pay only a portion of the cost of maintenance, it amounts in my opinion to a shirking of their proper responsibility, and taking the whole tenor of the Act, I believe that if a case was fought out, the decision would be that the local authority was entitled to the full cost of maintenance. You have in the Act a power of appeal to the Local Government Board, and I should like to know whether this point has been referred to them. With reference to the maintenance of the foot-

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paths, or side walks, of main roads, in an ordinary disturnpiked road, no question has been raised; the whole of the road, including the footpaths, having been taken to. If the Councils have taken to the disturnpiked road, including the footpaths, why should the question be raised about other roads which have been declared main roads, and to which the Councils have been asked to contribute the cost of maintenance? With reference to the method of determining the amount of the contribution to the local authority, the easiest will be to keep separate accounts, showing the actual materials and labour used on the roads. These accounts will be subject to audit, and I do not think that any difference ought to arise concerning them. The question has been raised whether the term "cost of the maintenance" includes cleansing, watering, and supervision. I think all surveyors will consider these items essential to, and a part of the maintenance, and I believe that this is another question which, if fairly fought out, would be determined in favour of the local authorities.

Mr. Silcock: I should just like to say a few words on this subject, and to congratulate Mr. Hooley on having brought this paper before us at this particular juncture. I take it there is no more burning question to surveyors of non-county boroughs than that of main roads. I may say, as representing one of those non-county boroughs, that we made application to our County Council to take over certain roads; the Council has taken over those roads, and we are now negotiating as to the amount of the subsidy for the maintenance of them. I take it there are many boroughs which do not provide a sufficient staff in the surveyor's office to keep and make out separate accounts for labour and materials spent on each road. My county surveyor asked me for such accounts for the last ten years, which it was impossible for me to give; but I was able to approximate the labour and materials, and to this I added certain other items, such as watering, cleansing, scavenging, &c. I found the county surveyor could not see it as I did, but claimed to make out the grant on the three years previous average cost of labour and materials only. There can be no question that the roads cannot be kept properly in repair without being watered and swept; but the County Councils take advantage of the word "towards" to escape their full liability for the maintenance of the roads. I see that the author of the paper agrees that the County Councils should pay all that the main road requires for its efficient maintenance in full. I think we all agree with him, and personally I wish I had Mr. Hooley to deal with as

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my county surveyor. It would be useful if some members who have made out claims as to footpaths, watering, scavenging, &c., would state their experience, and whether their claims have been allowed or not.

Mr. SPINKS: I have in my hand a report which I made for an Alderman of the Cheshire County Council in September last. At that time the Council was at a deadlock on the question of the maintenance of main roads, and this gentleman asked me to make a report as to the best way of dealing with the matter. The report which I made, and which was approved by the County Surveyor, is as follows:—

"9, ALBERT SQUARE, MANCHESTER,
"*September 6th*, 1889.

"DEAR SIR,

"MAIN ROADS.

"The ordinary meaning of the term is a road which is the means of communication between one town and another, and includes both the carriageway and footway thereof, although the old turnpikes were confined to the carriageway only. For the purpose of simplification, main roads may be classified as Urban and Rural.

URBAN ROADS.

"Where it is desired by local authorities to declare certain 'roads' as main roads, it would be well for the County Council to adopt some principle or standard as the minimum of excellence which they will require of the local authorities. The carriageway should have a suitable drain with gullies for carrying off the surface water, the surface should be paved with a hard sett having impervious joints laid on a stable foundation. The footways should be properly kerbed and paved either with flags, concrete, asphalt, or tiles. It may not be possible in all cases to obtain these requirements forthwith, but an undertaking should be obtained from the local authority pledging them to contribute some proportion of the costs (when incurred) of completing on this basis any roads the Council may determine to adopt.

"As an illustration, it might be proposed to declare as a main road one the surface of which under present conditions would require renewal say during the next five years: therefore it is only equitable that the local authority should bear some proportion of the costs when incurred. It should also be clearly understood that if by the extension of building operations on roads or portions of them that are unbuilt upon, any land is laid out to the road, then the obligations to make good that portion added should not be upon the Council, but upon the local authority.

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RURAL ROADS.

"The practice of constructing these roads varies in different parts of the county, generally they are formed of hard Welsh macadam, but in the eastern division a local sandstone-grit is used, which is of a soft and perishable nature and totally unfit for the purpose. A suitable and satisfactory road for rural districts can be formed as follows:—A shallow surface drain of agricultural drain-pipes with proper gullies connected thereto; a foundation for the carriageway to be of cinders with 6 inches of Welsh macadam laid thereon, the channels to be 1 foot 6 inches wide, of Rawtenstall or Bugsworth setts, the kerbs to be 3 inches by 12 inches, either rough granite or Rawtenstall stone, and the footway to be gravelled or cindered. It might meet the exigencies of the situation if only one footpath were formed. Generally each particular application would require considering on its merits, the local circumstances and requirements being noted; but in these also an undertaking should be obtained for the completion in aforesaid manner, just as in the urban districts.

"Finally, urban and rural roads completed on these principles would be suitable for the customary traffic, and would not be excessive either in first cost or maintenance; and the adoption of some such principles would throw the burdens on the right shoulders, as it would be manifestly unfair to call upon the ratepayers at large to provide what is justly due from the particular localities affected.

"Yours obediently,

"WM. SPINKS, Assoc. M. Inst. C.E.

"MR. ALDERMAN BEELEY,
"*Cheshire County Council.*"

Mr. VALLANCE: The remarks of the previous speakers seem to be rather in defence of the action of Nottinghamshire. My county surveyor (Nottingham) has seen fit to advise that the County Council shall pay the full expense of the main roads, that is for watering, cleansing, scavenging, and all other expenses that may be incurred on the roads. I am very glad to say I have made that arrangement, and so far it works very favourably.

Mr. SAVAGE: I am glad to find that Mr. Hooley takes such broad views as to the maintenance of the main roads. I do not believe in any system of contracting for this work in urban districts; I believe it is much better done by the authorities themselves. There seems to be no question that the word "towards" was simply intended to protect the County Council from having to repay any extravagant expenditure on roads in urban districts.

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Mr. STAINTHORPE: The experience of Mr. Vallance is quite different to that of mine. In my district I have a length of main road, and I have certain improvements to carry out in connection with same, but I can get the county surveyor to sanction nothing whatever with regard to footpaths, watering, or scavenging. He confines himself entirely to the carriageway. I mention that, to show that all the county surveyors do not sail in the same boat. I think some definite action should be taken by county surveyors on this question of main roads. There is just one other point with reference to the wages paid in Nottingham. Mr. Hooley says the wages of the men should vary from 12*s.* to 18*s.* per week. Is that not a mistake? I can only say I have great difficulty in getting labourers in my district at nearly double the former rate.

Mr. A. T. DAVIS: The last speaker rather deplored the fact that the county surveyors do not all sail in the same boat. I regret they do not all belong to this Association, for if they all belonged to this Association, I am sure they would settle matters with local surveyors as the author has settled them in his county. I think the present is a very opportune time for such a paper as has been presented by Mr. Hooley, not altogether from the point of view put forward by several speakers, but also from another point. It is proposed to change the title of this Association, and to distinctly include in the title County Surveyors, and I think the present is a most opportune time for a paper most interesting to all county surveyors, because it will become known among them, and probably induce them to join the Association. I am sure if they do, it will be to their benefit, and, perhaps, also to the benefit of the Association. As a county surveyor, I should like to say that in my county we have ceased to work on the average system, which has been so much condemned by other speakers, and have adopted the contract system; but unlike Mr. Hooley, we have not contracted with the urban authorities, but we have induced them to claim as they were entitled to, and in most cases an amicable agreement has been come to between the county and those authorities. A specification was prepared by me after conference with the various surveyors of the rural districts, and an agreement based thereon is now in operation. I understand in Mr. Hooley's case local authorities make overtures to the county: we make overtures to them. I prepared an estimate which was adopted by my Council, and overtures were made to the different authorities to undertake the work on the specification I prepared, and for that amount, and it is now in operation. With regard to urban authorities claiming

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under sub-section 2, section 11, of the Act, I think the phraseology of that section clearly proves that the authors of the Act did not intend that the whole cost of the roads in urban authorities should be paid by the county authorities. I treat watering, scavenging, kerbing, and channelling as luxuries to a certain extent. They are necessary to urban authorities, but they are not absolutely necessary to rural authorities, and I think that the object of the framers of the Act was that urban authorities should pay the extra amount.

Mr. G. Eaton-Shore: I think it would be useful to the members of the Association if I just explained how we are being served in my county. The author of the paper, to whom I shall be pleased to convey my thanks for having brought this matter before us, says, with regard to sub-section 2 of section 11, he fails to see why it should lead to any difficulty. I think before any of us will be able to get the thing on a satisfactory basis we shall have to take it into the law courts, and get a decision there as to its meaning, as we have to do with nearly every Act of Parliament. In Nottingham the author describes how the county have come to an agreement with the authorities, and do the work under a contract; but if the work is done under contract it leaves the county surveyor with an amount of authority which the Act does not justify him in asserting. We claim in Crewe to have our roads under our own control. The county gave us that control; of course they could not refuse it. The county decided to pay us a certain amount towards the maintenance of our roads. That was the first settlement. After a considerable amount of negotiation we got them to pay the whole amount, except establishment charges and watering. The scavenging we get paid for as before. This year they have been advised differently by their legal advisers, and they will pay us for footpaths and watering, but not for establishment charges, but only at the rate of three-fourths of the total amount spent on the roads. They did intend to refuse payment for footpaths, until they saw, by the decision in the Warminster case, that they were liable for footpaths, and then they took advantage of this word "towards," to pay us only three-fourths of the cost, which places us in the old position before the passing of the Act. I should like to have it more clearly stated whether the local authorities are compelled to enter into a contract. I do not think they are; I do not see why they should be. The Act simply says they shall maintain the roads, that they shall have authority over them, and that they shall be maintained to the

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reasonable requirements of the county surveyor. I should like to know that, because we have called for next week a meeting of delegates from all the urban authorities in Cheshire which are concerned, with the intention of putting the matter forward with a view to arbitration.

Mr. WAKELAM: I should like to ask in what years local authorities received 75 per cent. of the actual expenditure on main roads? Mr. Silcock said the county authorities should allow a certain amount for drainage. I fail to see why they should allow money for drainage, as the sewers are laid for the benefit of the people living in the houses abutting on the roads.

Mr. GLEDHILL: I believe that County Councils will not allow more than they can possibly help to local authorities. It is so in my county, where I have great difficulty in obtaining grants for road repairs, and have been disallowed payment for pitching a road with stone in order to widen it, and was told by the county surveyor that if he had the power he would not allow payment for the metal put upon it.

Mr. HOWARD SMITH: There is one question of considerable importance, especially from the non-county boroughs point of view, which has not been touched upon; that is, whether it is competent to include under the heading of "Maintenance" a sum for the annual repayment of principal and interest upon loans borrowed for the purpose of road-making. The previous speakers have approached this question apparently having in their minds only macadamised roads, but supposing a main road is paved with good stone setts throughout, then in that case, unless the repayment of the loan is taken into consideration, and the contribution of the County Council is to be based only upon the annual amount expended in maintenance, those urban authorities having paved roads for the making of which they have borrowed money, will be placed at a considerable financial disadvantage compared with those authorities having macadamised roads; therefore, I think such circumstance should be taken into consideration, and an allowance made towards the annual repayment of principal and interest upon loans.

Mr. EACHUS: I am afraid this is almost more a question of law than of engineering. In many cases it is not the county surveyor who is responsible for refusal to grant the amount asked for the maintenance of the roadways and footways in main roads. It is the Clerk of the Peace who lays down the law, and the county surveyor has to abide by the law as laid down. Even before the 1888 Act, I contended that footpaths were included in the main

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roads; and with reference to the present Act, an eminent parliamentary agent once told me that if you want to arrive at the spirit of an Act, go back to the old Acts and trace their history. Looking back thus to the old Highways Acts, I concluded, and it has now been decided, that footpaths or footways, as well as roadways, are included in the main roads. In answer to a question put as to whether expenses incurred in pitching, and similar works, are payable by the county, I would point out that by the 13th section of the Highways and Locomotives Amendment Act, 1878, the term "expenses" does not include any repayment of principal moneys borrowed, or of interest payable thereon, but only includes the cost of repairs defrayed out of rates. I put a question to counsel upon the new Act as to whether that restriction was rescinded, and the answer given to me was that it was practically, though not literally, rescinded. Under the old Act we were entitled to half our annual expenditure from the county, based on the expenditure of the previous year, and half that grant from the Government, making three-fourths of the expenditure, and, I take it, the passing of the Local Government Act was intended to give us something more than that—in fact, as the marginal note to the 11th section of the 1888 Act puts it, "The entire maintenance of main roads by County Councils." I believe it was intended, in the first place, if the County Council maintained the main roads they would have to pay the whole cost; if the local authority maintained them the County Council would then have to pay the whole of such an amount as the County Council would have expended on the roads, not such an indefinite sum as the local authority might think well to expend. That is, I believe, the meaning of the word "towards" in sub-section 2 of section 11 of the Local Government Act, 1888. If it meant, as some County Councils have contended, three-fourths of the entire cost, or such proportion as the County Council in each county thinks fit to give, it might mean one-half, or even less; or, in other words, the subsidy given by the Government, to ease the burden of the maintenance of the main roads from off the shoulders of the local authorities, might be diverted from the purpose for which it was intended, and the local authorities, instead of receiving the help intended for them, would be worse off than they were before the passing of the Act of 1888.

The PRESIDENT: It is very clear to me, having heard this discussion, that it would be extremely desirable if the county surveyors throughout the country would join our Association. They would then mix with the local surveyors with whom they are dealing;

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these matters could be thrashed out in a fair manner at our discussions and it would do both the local surveyors and the county surveyors immense good. It is also evident to me that a local surveyor would make an excellent county surveyor. He is well acquainted with these points, and if he were appointed a county surveyor, it would be much on the same principle as makes a poacher a good gamekeeper. I think we must thank Mr. Hooley very much for this paper. It is the first paper we have had by a county surveyor since they have been introduced to the Association, and I thank him very heartily for his paper.

The vote of thanks having been heartily accorded,

Mr. Hooley, in replying on the discussion, said: I thank you very much for having passed this vote of thanks. I am pleased to have succeeded in raising a discussion which I hope will help the matter in future. In answer to the questions which have been put, first by Mr. Brooke, as to the cost of the roads, and the figures I gave you, I may explain that the cost of the footpaths was not included in that amount. If Mr. Brooke will refer to the paper, he will see this year there is an extra payment of 3500*l.* for the maintenance of the footpaths and other matters, which the county think it is a right and proper thing to pay for. As to what Mr. Lobley said, I am sorry I cannot agree with him as to urban authorities not receiving their share of the repayments. The urban authorities make their share of the first payment, and ought to have their fair share of the repayment. My Council, I am pleased to say, do not make any quibble as to the cost; but they say they shall pay it, and do honestly pay it. In my county, every town has agreed to repair its own main roads, and we pay the cost of the roads. This remark also applies to Mr. Norrington. We don't shirk anything in Nottingham, we pay the actual accounts honestly. As to what Mr. Stainthorpe asks about the wages paid to the labourers, we pay our men the usual wages paid in the district. It would, I think, be very unfair to take the labour from the farmers, really the worst kind of labour, and pay higher wages than they pay. As to watering, you will find that we do pay for watering, if you look at the schedule to the paper. As to payment of principal and interest for roads paved with setts, I am afraid the gentleman who asked the question has not read the Act. The Act clearly says that the main roads, and the materials thereof, shall become the property of the County Council. It is not likely, therefore, that the Council will pay interest on money expended previous to their existence on those roads. Gentlemen, I again thank you.

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THE RIVER MERSEY.

By W. SPINKS, Assoc. M. Inst. C.E.

Introduction.

As this meeting is held in a city built upon the banks of a river second only in importance in the United Kingdom, and as many of you will probably see it for the first time, it occurred to me that a paper would help those of you from a distance to see how important a factor it is in the material prosperity of some three millions of souls who dwell within its watershed, as well as to those other millions who continuously embark and disembark at this great port, and who are otherwise interested in the continuance of its existence.

It would be well if I state at the outset that, so far back as 1876, when public attention first began to be concentrated upon the idea of the waterway to Manchester being made navigable to vessels of the largest class, my late lamented master, Mr. R. Vawser, M.I.C.E., one of our past Presidents, read a paper before the Warrington Literary and Philosophical Society dealing with the tidal portion of the river only; and that, before the same society in 1884, I myself read a paper on the same subject, dealing with the rivers beyond the tidal portion. Since that time a mass of information has been launched forth at the several inquiries held by Parliamentary Committees on the Manchester Ship Canal undertaking, and also at the various Local Government Board inquiries upon the sewerage schemes proposed for some of the towns upon the rivers; and there has also appeared in the press much matter bearing upon the subject. And it is from all these sources I have been able to compile this paper; and in addition my thanks are especially due to the following gentlemen, who have kindly placed at my disposal much valuable information:—G. F. Lyster, Esq., M.I.C.E., Edward Gittins, Esq. (Mersey Dock Board), Francis Wiswall, Esq., C.E. (Manchester Ship Canal), J. A. Saner, Esq., C.E. (Weaver Navigation), Thomas Ward, Esq. (Salt Union), C. R. Jones, Esq. (Garston Docks), R. Lewis, Esq.

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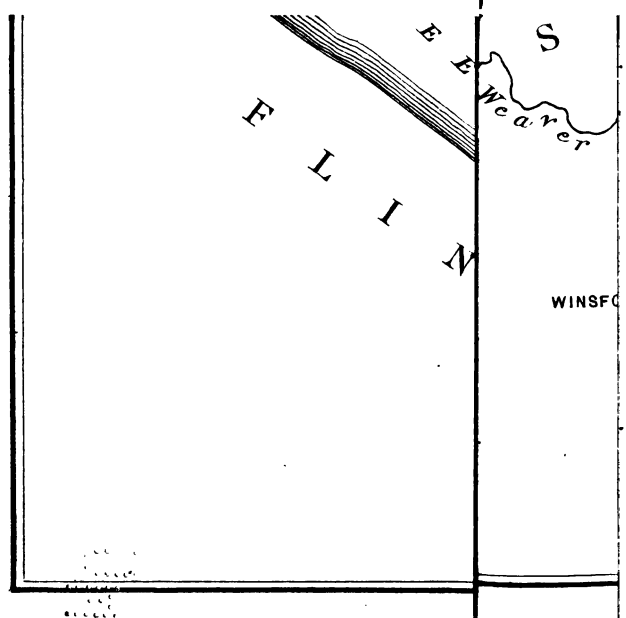

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(Widnes), Messrs. Laird Brothers (Birkenhead), T. H. G. Berry, Esq. (Manchester Corporation Waterworks), T. H. Ismay, Esq. (White Star Line).

Part I.—The Upper Estuary.

Geographical Description.

If you look at the map you will see that above Warrington there are two series of rivers spreading themselves out, octopus-like, over the country, the one rising in the north and flowing southwards, the other rising south and east and flowing north and west; the two main streams, the Mersey and Irwell, forming a junction at Irlam, flowing thence west through Warrington, where the tidal portion of the river terminates at Latchford Weir. Above this point the watershed area of the Mersey is 606 square miles, with an approximate present population of 500,000 persons. The tributary rivers are five in number, and are the Bollin, Dean, Goyt, Etherow, and Tame. The area of the watershed of the Irwell is 312 square miles, with an approximate present population of 1,700,000 persons.* The principal tributary rivers of the Irwell are the Medlock, Irk, Roche, and Tonge. As nearly as I can ascertain, the mileage of these rivers is as follows:—

	Miles.	Miles.	Miles.
Mersey		20	
Etherow	14		
Goyt	14		
Tame	20		
Dean	7		
Bollin	25		
		80	
			100
Irwell		40	
Medlock	12		
Irk	11		
Roche	13		
Tonge	10		
		46	
			86
Total non-tidal rivers			186
Tidal portion from Warrington Weir to New Brighton			28
Total Waterway			214

* For detailed particulars of the towns in the watersheds, see Table, pp. 225 *et seq.*

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But if this were actually measured along the river bed it would be considerably increased. To give an illustration of the sinuosity of the various rivers, it is found that the distance from above Bacup, where the Irwell rises, to Irlam, is twenty-two miles measured in a direct line, but measured along the river bed the distance is increased to fifty-one miles.

Rainfall in Watersheds.

The Irwell has its source at a point on Heald Moor called Erewell springs, about two miles north of Bacup, and at an altitude of 1325 feet above Ordnance datum, and in eight miles has a declivity of about 800 feet; the rainfall at the summit being about 58⅔ inches per annum, while at Salford it is 35⅔ inches, at Bolton 48, and Rochdale 43. There is thus a steady decrease from the summit to the plains. The same sort of thing occurs in the case of the other rivers, the Etherow rising above Woodhead Tunnel at a height of 1627 feet above Ordnance datum; the rainfall there being 58½ inches per annum, at the foot of the hills it is 46½, and higher up, at the head of the valley, 1000 feet above Ordnance datum, it is 53½, while at Manchester it is 35⅔. The same gradual diminution takes place on the east side of the range of hills towards Sheffield. It is computed that 170,000 gallons of water have been discharged by the Irwell in one second over the Throstle Nest Weir * at Manchester, and the minimum quantity discharged over the Warrington Weir was found to be 480 cubic feet per minute, and the maximum quantity (although it has never been taken accurately) is estimated at about 45,000 cubic feet per second.

How the Water is used.

It is an interesting speculation to reflect upon what uses all this volume of water has been put to before it reaches the tidal estuary to be carried away to the sea. If we can carry our minds back some 100 years, we can imagine we hear the roll of the mighty water-wheels which first set in motion the early motors and engines in use in the various industries that were plied at that time. As the steam engine superseded the water-wheel, the river came into use as a generating reservoir; and similarly has the water been applied to other purposes, called into being by the arts of the

* See Appendix A.

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chemist, in their application to printing and dyeing, and various other processes in Lancashire's staple industry. You thus see how great a factor this water has been in building up the prosperity of this large and important area. But there are other uses which are more germane to the interests of this Association. Much of the water is impounded before it gets far down the rivers, stored, and afterwards served out as the water supply to very many of the towns in the watersheds; the water flowing off 20,000 acres in the watershed of the Irwell being so used, and off 21,770 acres of the Mersey, the total present average daily use for towns being 5,932,200 cubic feet, and for compensation 5,198,000 cubic feet. The Manchester Waterworks in the Longdendale Valley form a chain of lakes extending seven miles, containing 960 million cubic feet.*

In addition to the water abstracted for this purpose, a considerable quantity is also impounded and stored for use in the various navigable canals which concentrate at Manchester, flowing thence viâ the Bridgwater Canal to Runcorn, where they eventually emerge into the Mersey.

Prevention of Floods.

In spite of all the water that is impounded and diverted, there has been, at times of exceptional rainfall, very heavy flooding in the low-lying reaches of the river, which has caused enormous damage both to property and stock.† The subject of their prevention has received attention at the hands of many eminent engineers, amongst whom may be mentioned the late Mr. J. F. Bateman. Much has been done to improve the scour of the various rivers by different Corporations, and especially by the Corporation of Manchester on the rivers Irk and Medlock, by keeping the channel confined within substantial walls, and so preventing both erosion and digression. But perhaps the greatest improvement of all has been effected by the adoption of the movable weir as invented by my friend Mr. Francis Wiswall, A.M.I.C.E., at present engineer of the Bridgwater Canals Undertaking of the Manchester Ship Canal Company, and who at the time of the erection of the Throstle Nest Weir was engineer to the Mersey and Irwell Navigation. The Throstle Nest Weir was erected in 1882 and

* See Appendix C. † See Appendix B.

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its success was so complete that it was decided by the Bridgwater Navigation to alter all the fixed weirs between Manchester and Warrington to movable weirs of similar design, but the interposition of the Ship Canal stopped operations after a considerable amount of money had been spent. By the courtesy of Mr. Wiswall I am enabled to show you a model of this weir, and its principles and parts are hereafter described.

Throstle Nest Weir.

The weir consists of a series of 14 rectangular sluice gates turning on a common axis, and when closed the gates, with the framework which supports them, present a surface to the stream of 1400 square feet = 140 feet × 10 feet wide, which is reduced to 293 feet or one-fifth of the obstruction when the gates are open. When closed the gates are inclined at an angle of 35 degrees from the perpendicular, and when open they are suspended in a horizontal plane. The gates retain their inclined position until the water of the river rises to 2 feet 9 inches above its ordinary level, when the back pressure is sufficient to cause them to tilt automatically and release the impounded water; in addition, drawchains are provided, by which any or all of the gates can be opened at will, and the impounded water gradually released. The river bed is laid with a sheathing of stone and timber, and is perfectly level, the breadth across the river being 140 feet and length down stream 33 feet. At intervals of 10 feet centre to centre across the river bed cast-iron piers have been placed, and these carry a turned shafting on which the sluice gates hang and turn in lengths of 10 feet. The tilting sluice gates, which are framed of English oak and planked with pine, are 12 feet long, 10 feet wide, and 9 feet below the axle. To the centre of the foot of each gate a drawchain is attached, and there are two multiple crabs, one on each side of the river, and each connected with seven of the gates, by which the sluices can be raised or lowered separately at will.

Pollution of Streams.

Having shown you where the water comes from, I will now consider the sanitary condition of the various rivers. In the beginning of the year 1888 a conference of nearly all the sanitary authorities in the watersheds of the upper estuary was called

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together by Lord Egerton, as Chairman of the Manchester Ship Canal Company, and took place in the Town-hall, Manchester, on 24th January, 1888. There were seventy-five authorities represented, and of that number only five were able to report that their sewage was dealt with entirely. Shortly after that meeting I issued a number of queries to the surveyors of the several authorities, with the object of ascertaining the causes of the pollution of the streams; and, taken as a whole, I found that there could be only a small proportion of fæcal matter discharged through the sewers, as, with the exception of Hyde, which is the only town absolutely on the water-carriage system, the whole of the towns were either on the midden or some form of pail system.

There is certainly a great deal of discoloration from the waste water from manufactories, and in some instances no doubt contamination, but no one can deny but that the condition of all the rivers has improved in this respect, and as chemical science progresses uses will doubtless be continuously found for the bye-products from most if not all processes, so that what does pass into the streams may be comparatively innocuous and inodorous, although it may be offensive to the eye, as it is not altogether possible to remove these disagreeable colours. I have already pointed out that in former years the river was used for turning waterwheels to a very large extent, and to facilitate this method of motion, a number of dams or weirs were constructed, which to-day are in a great measure useless, and many of them are in a ruinous state and prevent the uninterrupted flow of the water, and also cause much mischief in other ways, and the presence of large stones in the beds of the rivers adds to their insanitary condition. As a result of my observations in the dry seasons of 1884, '87, and '88 at Dukinfield, I found that there was little or no water in the river beyond sewage and compensation water, which owing to these obstructions travelled very slowly, and the matter in suspension grew around these stones and gave off very offensive odours. It is the custom on most of the rivers where the water is impounded for steam or manufacturing purposes, to let off the water from the lodges on Saturday afternoons, and then to impound fresh water; consequently, on Sundays, and often well on into Mondays, there is very little fresh water passing along the streams.

I have always been of opinion, if greater attention were paid to these disused weirs, and the stones removed from the river beds, and where the rivers actually pass through the towns, if the beds

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were inverted and paved, their general sanitary condition would be greatly improved. In some towns, I am ashamed to say, I have seen closets discharging direct into the river, and that is a condition of things that no sanitary authority should tolerate for a moment, otherwise they belie their name. Besides the liquid impurities that are poured into the streams, there are many solids too, and any one acquainted with their banks must have been astonished at the amount of solid matter that is so craftily tipped as to be washed away by the very first freshet. Indeed we find that in the report of the "Rivers Pollution Commissioners" in 1869 it states "that throughout almost the whole course of the various streams which here pass over the weir, not only has the water been polluted from both house and mill refuse, more or less in solution or suspension, but the river has been obviously made the recipient of furnace ashes, waste from spoil heaps of various kinds, and even earth removed from house foundations." In addition to this, there is considerable erosion going on in some districts, caused in great measure by the settlings over the shallow workings of the collieries; especially is this the case on the Tame, at Dukinfield and Denton. In the tidal portion of the river there is great pollution from the immense banks of chemical waste, deposited at St. Helens and Widnes, every time that it rains; this will always happen, and no amount of sewage purification will ever vary or diminish the evils caused to the rivers by that contamination.

Statutory Provisions to prevent Pollution.

In 1862 an Act of Parliament was passed, entitled an "Act to protect the Waters of the Rivers Mersey and Irwell and of certain of their tributaries from certain obstructions," and it is under this Act the Manchester Ship Canal Company have powers to take action against any offender under the provisions of the Act. In addition to this enactment there is the Rivers Pollution Prevention Act of 1876, with which you are all no doubt familiar. The Local Government Act of 1888, in Section 14, confers powers upon the County Councils to enforce the provisions of the Rivers Pollution Act, and Sub-section 3 of that section further confers powers upon the Local Government Board to constitute joint committees from the County Councils of the watersheds of particular rivers, and to confer upon them all the powers of a sanitary authority. The

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County Councils of Lancashire and Cheshire have not been slow to avail themselves of the powers conferred by this section, and have already memorialised the Local Government Board to constitute a joint committee, and each has laid its proposals before them; but as there is some slight divergence between them, a conference is arranged, at which it is anticipated a *modus operandi* will be agreed upon, so that we may shortly expect active measures to be taken to try and check any further pollution of these rivers. We all know how very cautiously and slowly sanitary authorities move in the direction of remedial measures, much of which may, no doubt, be set down to jealousy, and fear that by reason of the increased rates necessarily incurred by the execution of a sewerage scheme, trade may forsake a particular district and settle in one less heavily rated. Generally, the adoption of a sewerage scheme will mean an addition of from 4*d.* to 8*d.* in the pound to the rates, and it does seem invidious for the Local Government Board to single out one place when all alike are equally culpable, and when the mischief may still be going on at places higher up the stream than the town pounced upon. Reforms should be initiated where the pollution commences, and not at spots where the effect of cleansing is untraceable a few hundred yards down stream. There is no doubt that the proposed joint committee will be about the best piece of machinery to work the Rivers Pollution Act that could be devised, as they are certain, from their constitution, to deal out justice evenly, and to see that no offenders escape; they will have no interests to serve but the public benefit, and if the results of their acts do not turn out to be for the public benefit, when they go down to meet their constituents the matter will soon be set right. Of one thing there can be no doubt, that when the Municipalities have set their own houses in order they will keep a sharp eye on individual offenders, and evils from those quarters are sure to diminish. The approaching completion of the Manchester Ship Canal makes it imperative that no time should be lost in setting about the purifying of the waters it is to receive and retain, otherwise it may, and probably will, become nothing else but a chain of elongated precipitation tanks, from Salford the whole way to Eastham—a condition of things which can be very readily imagined, and from which the direst consequences may accrue, not only to the unfortunate residents contiguous to its banks, but to the parties responsible for the offences committed.

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Part II.—The Lower Estuary.

Having now learnt something of the sources and sanitary condition of the water, we will consider the uses to which it is put by the traders of the county, and for this purpose will commence at Liverpool, as that is where it was first put to navigable purposes.

Early History of the Port of Liverpool.

In early times Liverpool was deemed part of the port of Chester for customs purposes, and in 1646 the independence of Liverpool was asserted by its Corporation, but it was not until 1660 that they were successful; and in 1680 the boundaries of the port were defined "from the red stones on the point of Werrall southerly to the foot of the Ribble Water, in a direct line northerly, and so upon the south side of the said river to Hesketh Bank easterly." In the reign of Anne, 1709, an Act defined the limits of the Port of Liverpool to extend as far as "a certain place in Hoylake called the Red Stones, and from thence all over the River Mersey to Warrington and Frodsham Bridges." Prior to the commencement of the eighteenth century the banks of the Mersey in Liverpool existed in a state of nature, and were without any accommodation for shipping. Near the Custom House was a large pool running inland, and then known as the Old Pool, or Liver Pool. In 1709 the Liverpool Old Dock, the first wet dock ever constructed in England for the reception of vessels, was sanctioned by Parliament, and, although now filled up and its site occupied by the Custom House, the level of its gate-sill is preserved as the datum to which the tides and other levels of the Mersey are usually referred. The sill was laid 1 foot 9 inches below the ordinary level of low-water neap tides. In 1840 two Acts of Parliament were passed for the construction of the Harrington and Herculaneum Docks by private companies. In 1844 the Birkenhead Docks were sanctioned, and in 1855, together with the Herculaneum Dock, were transferred to the Corporation of Liverpool. In 1858 the whole of the various dock estates on both sides of the river, together with town dues and other sources of revenue, were transferred to the Mersey Dock Board, then first constituted.*

* See Appendix E, showing extent of docks on the river.

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Navigation of Upper Estuary.

On 17th June, 1720, an Act received the Royal Assent, entitled "An Act for making the rivers Mersey and Irwell navigable from Liverpool to Manchester." The preamble sets forth that "The making and keeping the rivers Mersey and Irwell, in the counties of Lancaster and Chester, navigable and passable for boats, barges, lighters, and other vessels, from Liverpool to a place called Hunts Bank, will be very beneficial to trade, advantageous to the poor, convenient for the carriage of goods and merchandise to and from the towns adjacent, and will very much tend to the employing and increase of watermen and seamen, and be a means to preserve the highways."

In the *Manchester Historical Recorder* there is the following memorandum:—"1721, June 6th. The rivers Mersey and Irwell made navigable to Liverpool for vessels of 50 tons."

In 1794, an Act received the Royal Assent, entitled, "An Act for altering an Act passed in the seventh of George the First for making the rivers Mersey and Irwell navigable from Liverpool to Manchester, in the County Palatine of Lancaster, by incorporating the Proprietors of the said navigation, and to declare their respective shares therein to be personal property." Under the reorganised company the navigation was considerably improved. In 1872, the Bridgwater Navigation Company was formed, and acquired both the Bridgwater Canal undertakings and the Mersey and Irwell navigation, and on the 5th August, 1887, the Ship Canal Company took possession of the properties of both these undertakings.

The Mersey and Irwell navigation is not strictly confined to the rivers, as from time to time cuts were made to avoid the bends in the river, and so save distance. The total length of the navigation from Hunts Bank, in Manchester, to Warrington, where it enters the tidal portion of the Mersey, is 19½ miles, and there are eleven locks to be encountered, having a total elevation of 58 feet.* As it is not practicable for vessels to navigate the Mersey from Warrington at all states of the tide, a canal was made on the Cheshire side to Runcorn, where barges can always get sufficient draught of water in the river. The distance from Warrington to Runcorn is 8 miles, and thence to Liverpool 16 miles, making the total length of the navigation 44½ miles or thereabouts.

* For particulars of this navigation, see Appendix D.

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River Conservancy.

The Corporation of Liverpool had always claimed to be the Conservators of the Mersey, but in this they were resisted by the Mersey and Irwell Navigation Company, and after much litigation it was established that the conservancy was vested in the company. This led to the Mersey Conservancy Act of 1842, which made special provision for the preservation of the navigation from Warrington and Frodsham Bridges to the sea, and constituted the First Lord of the Admiralty, the Chancellor of the Duchy of Lancaster, and the Chief Commissioner of Woods and Forests, "Commissioners for the Conservancy of the River Mersey," and they are empowered to appoint an acting Conservator to see that the conditions of the Act are observed. The Act prohibits any projection or encroachment on the tideway of the Mersey within the high water line of a 21-feet tide without notice in writing to the Acting Conservator, and declares such unauthorised encroachments to be nuisances.

The Upper Mersey Dues Act of 1860, transferred to trustees, upon certain trusts, the dues payable on goods or vessels carried along the Upper Mersey above an imaginary straight line from Eastham Ferry Slip to the north-westerly boundary of the Dock Quay at Garston.

The Upper Mersey, prior to 1876, was dangerous and difficult to navigate, the lighting and buoying being kept up by the traders without any legal obligations as to its maintenance; but in that year an Act was passed creating a Commission for lighting and buoying the Upper Mersey, and authorising the Commissioners to levy and receive certain rates and dues. This Act is known as the Upper Mersey Navigation Act, and its Commissioners are a representative body elected by the Corporations, Local Boards, Railway Companies, Navigation Companies, and Trading Associations concerned in the river, and their jurisdiction extends from an imaginary straight line, drawn across the river from Eastham Ferry Slip to a point on the north-east bank, distant 20 chains, in a south-easterly direction, from the lighthouse at Garston to Bank Quay at Warrington.

River Weaver.

While dealing with the lower estuary of the Mersey, omission must not be made of its very important tributary, the Weaver, which rises in the south-west of Cheshire, and flows through

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Nantwich, Winsford, and Northwich, and joins the estuary of the Mersey at Weston Point. Its total length is 51 miles, of which 21 are navigable. Along with its tributaries, the Weaver drains 550 square miles of land, or nearly one-half of Cheshire.

In 1721, three Cheshire landowners obtained an Act of Parliament to make it navigable to and from the Mersey to Winsford. By 1807, several locks and weirs had been built. In 1829, the Weston canal and a tidal basin, at its junction with the Mersey, had been constructed, and the navigation was divided into ten reaches by means of locks. Since 1843, the navigation has been shortened by means of cuts, the channels widened and deepened and the locks duplicated, with the result that sea-going vessels can reach Northwich. The largest lock at Saltersford is 229 feet by 42 feet 6 inches, and capable of accommodating vessels of 1000 tons burden. The top width of the navigation is 100 feet, the bottom width 45 feet, and the depth 10 feet; its total rise is 37½ feet. As is well known, the valley of the Weaver is the centre of the salt industry, and the settling caused by brine pumping has extended to a depth of 70 feet, and formed "flashes" or lakes on the river which serve as storage reservoirs for the supply of the locks. The annual quantity of rock salt mined amounts to 150,000 tons, and 1,500,000 tons of white salt is manufactured from the brine, and about 1,000,000 tons of this is annually shipped on the Weaver.*

Tidal Estuary.

In all these various Acts of Parliament, provision has always been made for the due protection of the estuary, founded upon the experience of successive acting conservators and marine surveyors, and it is a well-known fact that no river in England possesses the same characteristics in its estuary as the Mersey, and a most interesting paper could be written on that subject alone. Many eminent engineers have studied the question from time to time, and their experience and observations will be found recorded in the minutes of evidence of the various parliamentary stages of the Manchester Ship Canal Act. An inspection of the charts shows how varied and constant are the changes continually going on, nor is it to be altogether wondered at when we find that no less than

* For fuller information about the Weaver, consult 'Proceedings' of Inst. C.E., vol. lxiii. p. 261; also the report for the year 1889 of the Acting Conservator of the Mersey.

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100,000 cubic yards of mud and sand are daily washed from the upper to the lower estuary. It appears to be laid down as an undeviating rule, that in order to maintain the deep water channels and entrances, on no account must the "tidal backwater" be diminished. Seeing of how vast importance it is to the whole of England that the estuary should in no way be robbed of the agents which regulate and form its channels, it is easily to be understood, that those responsible for its conservancy should zealously watch over the diversion or abstraction of any portion of the waters from the upper estuary, so as to prevent the blocking up of the entrances to the docks of Liverpool or the mouth of the river.

Trade on the River.

In the early part of this paper, I referred to the millions of people who are indirectly interested in this river. In 1757, the number of vessels trading to and from Liverpool was 1371, and the dues paid amounted to 2337*l.*, while last year the figures had risen to 22,662 and 1,062,505*l.*, respectively.*

Continuing the illustration further, in order to show the increase in the size of modern shipping: in 1869, the pioneer boat of the White Star Line, the *Oceanic*, was put on the station; her size is 420 feet long, 40 feet 9 inches beam, and 31 feet in depth, and 3700 tons burden; whereas to-day, the *Majestic*, of the same fleet, is 582 feet long, 57½ feet beam, and 39⅓ feet in depth, and is 10,000 tons burden.†

From the extraordinary and rapid increase in the size and depth of vessels during recent years, it is hardly possible to forecast what may happen in the future; but one thing is certain, and that is that the utmost vigilance and care will have to be exercised to see that deep water is maintained at the dock entrances; otherwise, the trade of Liverpool may materially suffer, and the impending experiments of sand pumping at the bar will be watched with great interest not only by engineers but by the whole country.

Conclusion.

From the foregoing remarks you will be able to gather how great a power has been this river in building up the material prosperity of this important industrial portion of England. One

* For comparative table, see Appendix F.

† For progress of modern shipping, see Appendix G.

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hundred years ago it supplied the power to turn those water-wheels that set the early machinery in motion. About the same era, too, its waters were diverted into those wonderful canals by which Brindley revolutionised the whole system of internal communication. As the use of steam crept in, water power was abandoned and the mill goyt was used for a reservoir from which to draw the supply for generating purposes, and thus the river sides became more thickly studded with huge workshops. When sanitary reformers called the attention of the people to the danger of using the surface wells and the much-cherished pump, other sources of supply had to be sought, and engineers went to the heads of the valleys and impounded the streams and rivulets, forming some of the finest systems of water supply known. The trader, too, has from time to time made use of its waters, and commerce has called upon engineers to provide accommodation for the ever increasing multitude of vessels answering her calls. So to-day, by reason of the evolutions of mechanical science, we see upon its banks one vast industrial district extending in chains for miles and miles; at its mouth are the finest and most extensive docks in the kingdom, where are received the food supplies for millions of people; the raw material which shortly comes back from the hands of those people, in the form of manufactured products, to be sent all over the world. Upon its waters are afloat the most magnificent and marvellous vessels that the ingenuity of man has been able to devise and construct, and which ply to and from the greatest port the world has ever known.

APPENDIX A.

PARTICULARS OF GAUGINGS AT THROSTLE NEST WEIR, MANCHESTER, BY MR. T. B. FOSTER, C.E., IN 1883.

Date.	Time.	Mean quantity in cubic feet.
April 18th	Midnight to Midnight ..	19,450,000
April 18th and 19th	9 a.m. to 9 a.m.	20,400,000
April 19th	Midnight to Midnight ..	24,500,000
April 19th and 20th	9 a.m. to 9 a.m.	24,500,000
May 31st	Midnight to Midnight ..	15,241,000
May 31st and June 1st	9 a.m. to 9 a.m.	16,300,000
June 1st	Midnight to Midnight ..	17,843,000
June 1st and 2nd	9 a.m. to 9 a.m.	18,200,000

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APPENDIX B.

RECORD OF GREAT FLOODS AT WARRINGTON, THE HEIGHTS BEING GIVEN ABOVE ORDNANCE DATUM AND OBSERVATIONS TAKEN IN TIDAL ESTUARY.

St. Swithin's Day	1828 = 24·25	These heights can be understood when compared with the water levels of the canals running parallel to the river, which are 22 feet above O.D.
St. Thomas's „	1837 = 23·95	
17th November	1866 = 23·41	
*16th July ..	1877 = 20·75	
*17th „ ..	1877 = 21·82	
Level of Weir	= 16·67	

* On 14th July rain began to fall about 4 p.m., and at 9 a.m. on the 15th 1·40 inches was recorded. From then till 9 a.m. on the 16th, 2·83 was recorded, or 4·23 inches in about 40 hours.

APPENDIX C.

TABLE SHOWING AMOUNT OF WATER IMPOUNDED FOR WATER SUPPLY PURPOSES, AND YIELD OF WATERSHED IN EXTREME DROUGHT.

Name of District.	Drainage Area in Acres.	Average daily use of Water.		
		For Compensation.	For Towns.	Total.
		cubic feet.	cubic feet.	cubic feet.
1. Bacup	350	36,600	40,000	76,600
2. Bolton	9,340	1,383,000	876,200	2,259,200
3. Bury	3,815	275,200	400,000	675,200
4. Heywood	1,250	156,000	136,000	292,000
5. Oldham	3,280	257,920	480,000	737,920
6. Rochdale	2,122	149,680	200,000	349,680
	20,121	2,258,400	2,132,200	4,390,600
7. Manchester water from the Etherow Valley	19,300	2,700,000	3,400,000	6,100,000
8. Ashton-under-Lyne, Stalybridge, and Dukinfield (District) Waterworks, from the Tame Valley	2,470	240,000	400,000	640,000
	21,770	2,940,000	3,800,000	6,740,000
Natural yield of Irwell watershed estimated as giving in extreme drought	150,000	..	..	64,000,000

There are no waterworks of any importance except those enumerated above.

With the exception of Manchester and Ashton Waterworks, the figures quoted are from the evidence of Mr. T. B. Foster, C.E., before the Manchester Ship Canal Committee, 1883.

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APPENDIX D.

Mersey and Irwell Navigation.*

List of Locks between Hunt's Bank and Warrington.

Situation.	Rises. Ft.	In.
Howley Quay, Warrington	7	6
Woolston	6	0
Butchersfield	2	0
Millbank	5	0
Sandywarps (removed)	0	6
Calamanco	6	0
Holmes' Bridge	4	0
Stickings	3	6
Barton	7	6
Mode Wheel	7	0
Throstle Nest	9	0
	58	0

Table of Distances.

	Miles.	Fur.
Hunt's Bank to Albert Bridge	0	5½
Albert Bridge to Barton Lock	5	6
Barton Lock to Sandywarp's Lock	5	2½
Sandywarp's Lock to Butchersfield Lock	4	7
Butchersfield Lock to Woolston Cut	1	4½
Length of Woolston Cut	1	6
Woolston to Latchford Lock	0	5
Latchford to Runcorn	7	7
Runcorn to Liverpool	16	0
	44	3½

* From the *Ship Canal News*, June 23, 1888.

APPENDIX E.

Particulars of the Extent of Dock Accommodation on the Mersey.

Total Area of Docks and Quay Space.

Port.	Water Area. acres.	yards.	Lineal Quayage. miles.	yards.
Birkenhead	164	2538	9	779
Garston	14	2494	..	1566
Liverpool	381	526	25	1061
Liverpool (Manchester Ship Canal Company)	2	1336	..	..
Runcorn	15	..	3	880
Weston Point	8	..	1	373
Widnes	11	2000	1	1330
Total	596	4054	44	709

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APPENDIX F.

TABLE SHOWING GROWTH OF SHIPPING TRADE AT LIVERPOOL.

Year.	Vessels.	Tonnage.	Duties.
			£
1760	1,245	..	2,330
1800	4,746	450,000	23,400
1824	10,000	1,181,000	131,000
1838	14,820	2,026,206	146,000
1856	20,886	4,320,618	326,800
1868	20,218	5,497,924	666,400
1880	20,070	7,524,533	982,378
1884	23,940	8,800,362	965,258
1889	22,662	9,291,964	990,551

A greatly reduced scale of rates came into operation on January 1, 1881. On March 1, 1884, a reduced scale again came into operation.

APPENDIX G.

TABLE SHOWING PROGRESS OF STEAM SHIPPING. VARIOUS VESSELS BUILT BY LAIRD BROTHERS.

Year.	Name.	Size of Vessel.	Tonnage.	Draught.	Speed.
		ft. ft. in. ft. in.	tons.	ft. in.	knots.
1840	H.M.S. *Dover* (first iron mail steamer)	113 × 21 0 × 9 10½	228	7 0	10–11
1846	H.M.S. *Birkenhead* (first iron frigate)	210 × 37 6 × 22 6	1,400	16 0	11
1847	*St. Columba* (mail steamer)	190 × 27 0 × 13 4	697	9 0	14½
1860	*Ulster*, *Munster*, and *Connaught* (mail steamers)	334 × 35 0 × 19 0	2,040	13 0	18
1870	H.M.S. *Vanguard* (armour clad)	280 × 54 0 × 24 0	3,774	20 10	14·94
1871	*Spain* (Atlantic passenger steamer)	425 × 43 0 × 36 0	3,925	20 0	14
1885	*Ireland* (mail steamer)	360 × 38 0 × 19 0	2,590	13 6	22
1889	*Columbia* (Atlantic passenger steamer)	463 × 56 0 × 35 8	7,163	22 6	20
1890	H.M.S. *Royal Oak* (armour-clad battle ship)	380 × 75	14,150	27. 6	17½

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DISCUSSION.

Mr. A. PARRY: I have very great pleasure in proposing a vote of thanks to Mr. Spinks for his admirable paper. It is not a subject which many of us can discuss; but it is of great interest to many who, like myself, are natives of the county.

Mr. A. M. FOWLER: I have very great pleasure in seconding the vote of thanks to Mr. Spinks for his useful and valuable paper. The paper is very useful indeed, as it contains many tables of statistics, which may be used as reference. It has also come at a very opportune time—when Lancashire is up in arms against the pollution of the Irwell, and when the Ship Canal is fast on its way to completion. The paper comes with very great force now, for when the canal is completed the river will be almost entirely changed in its flow, in its direction, and as a water carrier and as a highway. It is a highway now to a certain extent, but it will become a much more important highway when it becomes a highway for "over-sea traffic." The waters of the Irwell will then have to be locked up, and that will consequently create a number of large pools. In forming those pools, it will necessarily follow that there will be a great amount of subsoil water drained into them, and if that water is polluted with sewage from the towns, these locks or pools, whichever you like to call them, will act as precipitating reservoirs; and, as the banks of the canal have sloping sides, it will also naturally follow that there will be a large accumulation of filth on them. Although the water passes at a considerable rate over the weirs, the water in the pools will form a still head, and will therefore be perfectly quiet, and have the means of precipitating flocculent matter in itself. What a dreadful source of disease these cesspools would be to men who come fresh from the ocean! It is all very well to say that people work in the London sewers, and in the Cardiff sewers, but they are men who are inured to it, and men who did not get killed in the training; but bring men fresh from the ocean to the sewage pools of the Irwell, and do you mean to tell me that these cesspools would not affect the health and lives of such men? It behoves the Ship Canal Company to very carefully watch their customers and those whom they employ. This paper comes at a very opportune time, and ought to act as a caution to those who are concerned. At present it is very nearly all talk, nobody is doing anything to purify the sewage, and my idea is that it will

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be discharged into the river in five or ten years to come as it is to-day.

Mr. E. PRITCHARD: I, like the previous speakers, must thank the author of the paper for giving us such a treat. Not only is it a treat historically, but it is instructive. To this Association, as an association of sanitary engineers, I must re-echo the sentiments of the author of the paper, and so strongly amplified by Mr. Fowler, as to the future of this great canal from Liverpool to Manchester. As an engineering work I am sure we shall be only too glad to see its successful completion. As to its being a competitor with Liverpool and its trade, we may hold different opinions, but we must all hold the some opinion on this important point, as to the pollution or non-pollution of the waterway between Manchester and Liverpool. The author has referred to a meeting of several authorities in 1888, for the purpose of preventing that pollution which was then anticipated; and I should like to draw the author's attention to what he calls water-carried sewage, and also to the fact that some years ago, in reporting on the Mersey and Irwell watershed—the basins of the Irwell and Mersey—the Royal Commission drew careful attention as to pollution as between the sewage of a water-closet town and a midden town. I should like him to give us his opinion upon that particular form of pollution, and the result of his inquiries as to the possibility or probability of pollution of the canal when completed —that is, the pollution from the closet town, as compared with the non-closet town, and taking into consideration the opinion of the Royal Commission.

Mr. G. F. DEACON: This paper is a most useful addition to my knowledge of the river Mersey, and I thank the author for having presented it. It is almost twenty years since I was first consulted as to the Mersey, and I have ever since kept up my knowledge of the river. I see the author has adopted one of my figures in his paper. He mentions 100,000 cubic yards of mud and sand as being daily washed from the upper to the lower estuary; the lower estuary being, I should say in explanation, Liverpool Bay, and the upper estuary being all the tidal portion above the mouth of the river at New Brighton. The 100,000 cubic yards was about the volume of silt which, as I determined by experiment, is brought into the inner estuary on each 21-feet tide, but it is not of course right to assume this to be the average volume, which would be less as the height and volume of the tide is less. Inasmuch as the volume of the inner estuary has remained practically constant for

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at least 100 years, and probably for a great deal more, it is perfectly clear that the mean volume of silt brought into the inner estuary (something less of course than 100,000 cubic yards) twice every day, is carried out again—not necessarily exactly the same silt, but an equivalent quantity. It is most important to fix this fact in one's mind before considering the next important step in connection with the *régime* of the estuary. I find that if all the silt were deposited, it would raise the bed of the estuary about one foot per annum, wherever the level of mean high water was 10 feet above that bed. This simple fact makes it sufficiently obvious that if the power to carry back the silt to the sea were removed, the inner estuary of the Mersey would disappear in a very short time. Investigating in detail the mode by which the silt is taken back, I find in round figures that about half the whole volume—I will speak, for simplicity, of a 21-feet tide—about half the whole volume of the 100,000 cubic yards, that is to say about 50,000 cubic yards, of silt remains in suspension in the water and is taken back by the tide that brought it in. The remaining 50,000 cubic yards is probably deposited in different parts, according to the quiescence of the water; and, in the upper part of the estuary at least, the tide ebbing over the sandbanks has, speaking generally, no power whatever to lift it up again and carry it away. With the exception of a comparatively slight quantity, it remains where it was deposited a few hours before. There is, however, in this river, as in all alluvial plains with which the hand of man has not interferred, a low-water channel, and it is by the action of that low-water channel, and by that action only, that the greater part of the equivalent volume of the 50,000 cubic yards of silt deposited from the 21-feet tide is returned to the sea. It is true that the proportion touched by the channel of the actual volume of silt brought in by each tide is insignificant, but as the banks formed by the tide grow, the channel erodes them laterally, in virtue of the ever-changing serpentine figure with which we are all so familiar in alluvial plains.

Fig. 4 is a typical section of such a channel, and is probably nearly an average of the low-water channel in the upper estuary of the Mersey. The concave bank, i. e. the bank into which the channel is, for the time being, eating, being the older bank, is necessarily the higher of the two. It averages about 15 feet in height from the bottom of the channel. The depth of the channel, measured from the lower bank, is about half that, or

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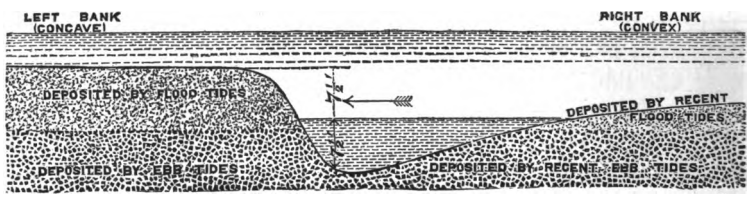
7½ feet, so that in round figures it comes to this, that as the channel moves laterally towards the higher bank, that is in the direction of the arrow, it cuts away the sand and silt and re-deposits about half of it on the convex bank in order to maintain its *régime*. In consequence of their different modes of formation, it is therefore convenient to call the higher bank the tide-built bank, and the lower bank the channel-built bank. With these figures before one it is not difficult to see that an enormous quantity of silt may be carried away by the lateral erosion of such a channel. But the most interesting fact probably still remains to be stated (still speaking of course in very round figures), viz. that the low-water channel of the Mersey traverses laterally an area about equal to the area of the inner estuary, on an average once in ten years. I have calculated also, that this being so, the volume of sand and silt eroded by the low-water channel is nearly equal to half the volume of silt brought in upon all the tides in the same period. We therefore,

FIG. 4.



inevitably I think, arrive at the conclusion that for every unit volume of silt brought in by a tide, about half that volume is carried back to the sea by the same tide undeposited, and about half is deposited and taken back by future tides, often many years later. The most important fact in connection with the investigation is the inevitable conclusion that the keeping open of this estuary, and I may add of many other estuaries also, depends upon the freedom with which the low-water channel is allowed to move about and erode the sandbanks. Any training, or even any work which tends to give the low-water channel a preference for one part of the estuary rather than for another, is detrimental, and if it largely reduces the lateral erosion, must be fatal. It cannot be too strongly urged therefore that important though the training of a low-water channel for the purposes of inland navigation may be, it can never be undertaken without bringing about the silting up of the tide-covered banks through which the channel flows; and

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should not therefore be undertaken if the tidal capacity of the estuary is important to the scouring of sand from the mouth of the river, or if the depth at parts removed from the channel is important to riparian communities. In Liverpool we are entirely dependent upon the tidal capacity of the inner estuary. If it were reduced, the internal waterways of our estuary would be reduced, and our dock entrances would become closed; while a secondary but final blow would be the inevitable diminution of depth in the bar channel, which would close altogether if it were not for the scour derived from the tidal basin charged twice daily by the water flowing past Liverpool.*

The PRESIDENT: I personally am greatly indebted to Mr. Spinks for this paper on the River Mersey. I am unable to add anything to the discussion, as I have only been here a short time. But I have learned a great deal from the paper, and a great deal from the admirable description Mr. Deacon gave us of the deposits in the River Irwell and the River Mersey. This paper and the remarks of Mr. Deacon will form a most valuable addition to the Minutes of our Proceedings, to which we shall be able to refer when any question arises affecting this district.

The vote of thanks having been accorded with acclamation,

Mr. SPINKS, in acknowledgment, said: I beg to return you my sincere thanks for your kind vote in approval of this paper, and I am very glad I have been able to collect so much information for reference in the pursuit of your ordinary work. Mr. Fowler, very powerfully I think, argued that it is to the interest of the Ship Canal Co., and the authorities upon its banks, to see that the waters of the canal are in such a state that they shall be entirely harmless to the seamen and others who come up fresh from the ocean. It is a very singular thing that I picked up a newspaper this morning which had the following paragraph, which fully sustains what Mr. Fowler said to-day:—"At the fortnightly meeting of the Altrincham Union Rural Sanitary Authority, held at Knutsford yesterday, Dr. Fox, medical officer for Mid-Cheshire, reported on a death from typhoid fever which had occurred in the township of Partington under peculiar circumstances. He said it was one which they must regard most seriously. A young man, 21 years of age, a bread-winner, the support of his mother, was carried off by a preventible disease, leaving her possibly to be a charge upon the rates. The

* For further information on this subject, see vol. lxxxiv. p. 301, of the 'Proceedings' of the Institution of Civil Engineers.

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cottages, in one of which the young man lived, abut upon the River Mersey, which here, as elsewhere, has no other appearance and character than that of an open sewer. After a long investigation, the conclusion he had arrived at was that the putrid emanations from the water, and especially from the banks left exposed when the water was low, were the cause of the fever in this particular case. Would it be possible, having regard to the vast interests of local industries, to bring the river into a state of decency? If so, by what body, or combination of bodies, should the gigantic task be undertaken? He had thought it right to draw attention to this exceptional death from typhoid fever, as showing the injurious influence upon a stranger of an atmosphere following the course of the river laden with every kind of abominable odour, to which those who had been born and bred in the neighbourhood seemed to be insensible and indifferent, possessing the immunity which was often associated with acclimatisation." I think that exactly bears out what Mr. Fowler has expressed this afternoon. Mr. Pritchard asked for an opinion, or some remarks at any rate, upon the report of the Royal Commission in 1869. Since that time most of the towns in the upper estuary have been put into a much better condition. They are paved, and in a much sweeter condition than when that report was issued. We have also impervious pavements and better scavenging, so I do not think we have such bad conditions now as then. There are no towns on the water-carriage system, but the towns on the midden system—which I think is a barbarous system—are in a better state than they were twenty years ago. If the paper has done nothing else, it has been useful in drawing from Mr. Deacon a full and exhaustive statement on the tidal estuary of the Mersey. With regard to the area of the watershed above Throstle Nest Weir, it is 270 square miles. It would have been presumptuous for me to have ventured any remarks or opinion upon the water in the estuary, and the 100,000 cubic yards of sand and mud I referred to was taken from the report of Admiral Evans, one of the Acting Conservators of the Mersey. That report was anterior to the reports of the last seven or eight years on the Ship Canal question. It is only during the present week that Mr. Deacon has been in the box giving evidence on the subject, and I must thank him for calling attention to it. It is a very valuable addition to the Proceedings of this Association.

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of Water S	a Sewera	much pollution from nufacturers' waste?	Is there much obstruction in bed of river from stones or heavy deposits?
reservo nfield eshaw.	No.	No.	Yes, at Huncliffe Weir.
Manches	Yes.	None.	Very little.
Bolton C	Yes.	No.	No.
Ashton erworks.	Not ye	Yes.	A little.
ndale pany	Yes.	Not much.	No—the heavy stones are removed annually.
Man oration.	ewers bu ltering v	uch polluted, but nuch by manu- rs' waste in Eccles tricroft.	No.
ge reservo	Yes.	m dye and bleach higher up the	Not very much, principally what is brought down during heavy floods.
Manc ks.	Yes.	out Macclesfield yal, none in this . River some- so impure as to any fish, to the oss of the Angling tion.	No.
ration G Scheme.	lans in	dye, chemical per works at pre- urn their waste river.	Yes—brought down from the upper reaches.
Rochdal ion.	No.	No.	No.
Local Sur	be a mod		

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Is there much pollution from manufacturers' waste?	Is there much obstruction in bed of river from stones or heavy deposits?
A little discoloration, but suspended or deposited matter almost nil.	Very little.
No.	Moderate.
Water turned in purer than the river water.	No.
Yes.	No.
Very little.	No.
Only from print works.	Yes. Bed wants thoroughly clearing out.
No.	No.
No.	No.
Not much.	Very little.
No.	No.
No great deal.	No.
Some.	No.
No.	By large stones or rock.
..	Yes.

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Water Sup	Sewerage Sc	ch pollution from turers' waste?	Is there much obstruction in bed of river from stones or heavy deposits?
ochdale n.	of const	than is consis- the manufac- ried on here.	No.
olton C	nt with B Sanitary	None.	
ury Cor	ns have	able amount by tricts, but not	No.
d from w	Yes.	No.	Considerable amount of ordinary silt, arising from existence of weirs.
..	t present.	No.	Not much. Weirs are pretty frequent.
Stock Company	Yes.	district, chiefly nt works above	Yes, from stones.
Vaden Va	e under n.	dyeworks and .	No; but there are several weirs across the river, which cause silting-up to a great extent.
ochdale n.	e in pre	deal from the	Yes, from stones and weirs.
shton Di works.	No.	not, but the polluted by the ale works.	Only as above.
Heywood n.	Yes.	knowledge any	None.
..	..	No.	No.
Manchest n.	ot yet.	No.	No.
ester and	e under n.	ot much.	No.
orporati	we are	oderate.	Much as usual.

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Is there much pollution from manufacturers' waste?	Is there much obstruction in bed of river from stones or heavy deposits?
Yes.	Bed of river has no doubt been much raised, and is very rough and stony in places.
Yes, from woollen mills, paper and dye works.	There is a deposit in bed of the Roche in certain places, behind weirs, for example.
No.	No.
None from Sale, but river much polluted by towns above us.	Very little.
Not much.	A little from stone.
Can't say.	
None; only sewage from Old Trafford end of district—about 14,000 population.	None.
A little from dye and bleach works.	No.
Yes; some firms are beginning to apply some treatment though.	Not very much.
Yes.	Yes.
No.	
All manufacturers' waste flows into the brook after-leaving their soap-tanks and the brooks are very badly polluted.	

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TRACTION ENGINES AND THEIR EFFECT ON ROADS AND BUILDINGS.

By J. H. BURTON, Surveyor to the Audenshaw Local Board.

Traction engines may be, and no doubt are, exceedingly useful and economical in hauling heavy loads from place to place; but it cannot be denied that the wheels in general use, fitted with the usual cross plates, are a source of great damage to the roads traversed, and that the buildings near the roads suffer severely owing to the vibration caused by the working of the engines. It would be a waste of time to attempt to prove this, as all persons who have had any experience will be willing to admit the facts. Some local authorities and private individuals have endeavoured to obtain compensation for the injuries, but if contested the necessary proceedings are exceedingly costly, and the results (to say the least) are very uncertain. Some time ago I was instructed by my board (in conjunction with the surveyors of adjoining districts) to make frequent observations as to the working of traction engines; to take a careful note of any damage done, and generally to prepare a case for legal proceedings. In carrying out these instructions I came across a traction engine fitted with Boulton's patent spring wheels, the working of which I have carefully watched on scores of occasions, and I have found that the injury to the roads was almost if not absolutely *nil*, and that vibration was reduced to a minimum. On no occasion, whatever might be the state of the weather, have I noticed the wheels to slip, which is one great source of damage. My experience is confirmed by persons who reside or have business premises on the route traversed by the said engine, and by the surveyors of Gorton, Openshaw, Stalybridge, and Ashton-under-Lyne. I am certain that the new wheels are a great improvement on the old ones; and, if a better invention is not forthcoming, it would be well to try to obtain their general adoption. It is too much to expect that local authorities will be empowered to prevent the employment of such engines, and knowing as I do the trouble caused by their use in

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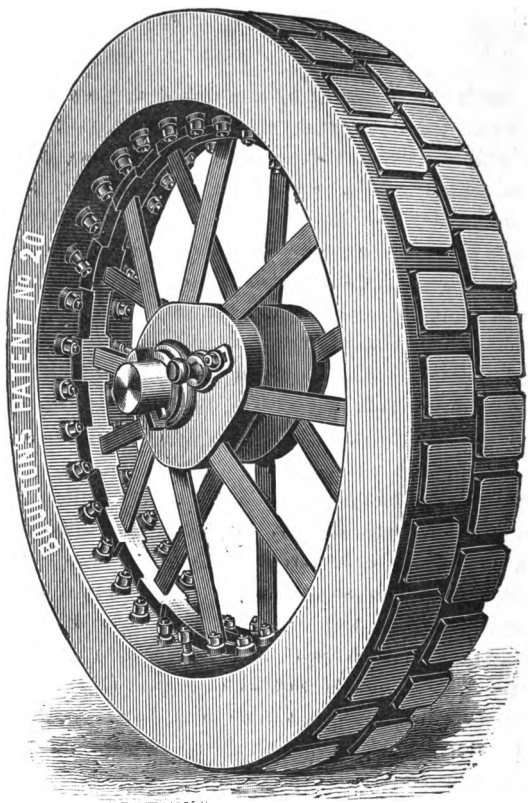
many localities, I venture to bring the invention to the notice of my brother surveyors, in the hope that it may be of service to them.

The wheel in question is called Boulton's patent traction engine wheel, and has been patented by Mr. I. W. Boulton, engineer, of

FIG. 5.



Ashton-under-Lyne. The following is a brief description of its construction:—The driving wheel (which was formerly the principal cause of the damage to the roads and the vibration complained of) is about 7 feet in diameter and 16 inches on the face. The periphery of the wheel is divided into sixty-eight cells or compartments, about 6½ inches square and 9 inches deep. In

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these cells or compartments hard wood blocks are loosely fitted, so that they will move easily about, with the grain of the wood pointing outwards, each block being bound round with an iron strap about $\frac{3}{4}$ of an inch from the end. The blocks are bedded on an indiarubber or other pliable cushion about $5\frac{1}{2}$ inches square and 1 inch thick. The blocks are loosely attached to the wheel by a bolt let into the wood block several inches, the head of which is covered by a wooden plug, and which bolt passes through the indiarubber or other cushion, and is secured on the inner rim of the wheel by a nut. As the wheel revolves, the weight comes on three, four, or five of these blocks, as the case may be. The indiarubber or other washer gives way, the bolts are pushed up, the blocks adapt themselves to the surface of the road, and have very much the effect, as has been described, of the putting down of an elephant's foot. Perhaps a better idea of the construction of the wheel may be obtained on referring to the accompanying illustration.

In confirmation of my favourable opinion, I give the following extracts from the proceedings of the last meeting of the Ashton-under-Lyne Town Council. "It was resolved that no travelling fee be charged for traction engines with Boulton's patent spring wheels passing through the borough, except in the event of actual damage being done."

"The Mayor, in moving the confirmation of the minutes, said the Council would see from one of the minutes that the committee had agreed to accept, without cost, traction engines fitted with Boulton's patent spring wheels. They found that these wheels did little or no damage whatever, and they thought it would pay them better to admit these engines than admit other traction engines with the ordinary wheels at the usual payment."

DISCUSSION.

Mr. PLATT: I don't know anything about this particular wheel; I have not observed it personally, but anything which will tend to obviate the damage caused by traction engines must be hailed with pleasure by surveyors of large towns. Those who have not observed it can have no idea of the extent of the damage caused to pavements by the old cross-barred wheels. I have three samples of paving setts here, which I have brought with me—one a flagstone, and two from Newry in Ireland—for the purpose of showing

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you the damage caused by traction engines. The damage done in my borough is shameful, and according to the present law there appears to be little or no remedy. On one road in particular it would have paid our Corporation to have carried every bit of the material for nothing rather than submit to the damage which has been done. While I don't believe in patented articles being brought before this Association, it is a very good thing to have this vexed question brought before us. I find that a hard basaltic stone, like Penmaenmawr, does not stand such traffic as well as the tougher stone of Carnarvon. I have seen 4-inch setts sheared off to an edge of about one inch. Mr. Cartwright at Bury is in the extraordinary position of having the power of dealing with traction engines, as they have obtained clauses in a recent Local Act that no engines shall come into their borough without notice, and that no engine shall travel without paying for the damage, towards which the sum of 100*l.* has to be deposited. The engine is followed up by a Corporation man with a tar brush, and every stone that is damaged is marked, and his men go and take them up and repair or replace them, as may be necessary.

Mr. SPINKS: I have much pleasure in moving that the thanks of the Association be given to Mr. Burton for his paper on Traction Engines and their Effects on Roads and Buildings. This particular wheel of Boulton's I have had many opportunities of seeing at Ashton-under-Lyne and Stalybridge, and, so far as I can judge, there is absolutely no damage whatever caused by it, and it is almost noiseless. It is undoubtedly a great gain over the old type of engine with cross bars. At Dukinfield we were much troubled with traction engines, three of them with a load of 5 tons to a wheel, in addition to which some of the boilers will weigh as much as 18 tons. This led me to make a careful inspection of damage, particularly to bridges, and in one case I found the wheels had gone through the cantilevers of the bridge. The result of my experience is that with these engines the local stone and Derbyshire stone is speedily split, and the Clee Hill and Penmaenmawr stone they cleave asunder. The flagstone granite rocks from Newry I did not find so badly treated as the specimen Mr. Platt has brought us, and with the Carnarvon granite stone there was no defect at all. I have paved a road on a 4-inch foundation, and I have found the setts were perfectly intact after the engines had gone over. There was one occasion on which an engine was going over Newry setts when I saw the driver putting lumps of sand-

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stone under the bars of the wheels, to get a bite. I watched him very closely, as I thought there would be very serious damage, but I am happy to say there was none at all. I remember on one occasion speaking to a friend of mine, who was an owner of two traction engines, and I said to him, "These things are perfect demons to my roads;" to which he replied, "Your roads are a nuisance to these bars; I have to pay ever so much for repairs." I have pleasure in proposing the vote of thanks to Mr. Burton for his paper.

Mr. PARRY, in seconding the vote of thanks, said: I think roads paved with setts suffer more from traction engines than macadam roads. When the Act was passed allowing the use of locomotives on the roads we did not put any restriction upon them, and I have never found a place where the cross bars have hurt a road.

The PRESIDENT: Before leaving the chair I beg to propose a hearty vote of thanks to the Mayor for the loan of this Council Chamber for the meeting to-day. Wherever the Association have held their meetings the Mayor and Corporation have always accorded them the use of the Municipal Chamber. Liverpool has been no exception to the rule, and indeed we have had the opportunity of having our luncheon in the palatial room of this old Town Hall.

Mr. C. JONES, in seconding the vote of thanks, said: It has afforded us great satisfaction to have accorded to us this splendid room for our meeting, and we have every reason for thanking the Mayor and Corporation of Liverpool for its use.

The resolutions of thanks were adopted with acclamation.

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VISITS TO WORKS.

(1.) *The Mersey Docks, &c.*

On Friday, June 27th, the members of the Association visited and inspected the magnificent system of docks, quays, and buildings on the Mersey, the property of the Mersey Docks and Harbour Board. The total area of the estate belonging to this great commercial trust is 1083 acres in Liverpool, and 506 acres in Birkenhead. The total lineal quayage of the Liverpool Docks is 24 miles 185 yards, and of the Birkenhead Docks 9 miles 110 yards, while the seven Liverpool basins have a further quayage of 1 mile 376 yards. The graving docks of Liverpool have a total length of floor of 12,489 feet 10 inches, and those of Birkenhead measure 2430 feet, making a total length of 14,919 feet 10 inches. The total length of the Liverpool gridirons is 822 feet 6 inches. The total water area of the Liverpool Docks is over 362 acres, of the Liverpool basins 18 acres, and of the Birkenhead Docks 159 acres, making an aggregate of 541 acres. Of the three land stages belonging to the Mersey Dock Board, the Liverpool stage is 2063 feet long by 80 feet wide, and has seven bridges connecting it with the shore; the Woodside stage is 800 feet long by 80 feet wide, and is connected with the shore by two bridges; and the Wallasey stage is 350 feet long and 70 feet wide, and connected with the shore by two bridges. The dock warehouses have a total capacity for storage of 427,462 tons, and the lairages have accommodation for 7655 cattle. There are over 26 miles of dock railway in Liverpool, and 35 miles in Birkenhead. Thirty-seven hydraulic cranes, four steam and forty-two hand cranes, are available for general use in the Liverpool Docks; and four hydraulic, one steam, and nine hand cranes in those of Birkenhead.

The members assembled at the Harbour Master's office, James Street, at half-past nine, and drove to the Herculaneum Dock, where they inspected on the east and south quays, the 60 fireproof magazines for the storage of petroleum excavated in the solid rock, and each capable of holding 1000 barrels; and the new tanks which are being constructed for the storage of petroleum in bulk. There are at present under construction, tanks capable of storing 9500 tons

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of petroleum, each tank being surrounded by a moat, as a precaution against the spread of fire. It is the intention of the Dock Board to erect here eventually six depôts, with a total storage capacity of 19,000 tons. The Toxteth dock-sheds, fitted with hydraulic cranes for the loading and unloading of vessels, and the Coburg pumping station, with pumps capable of lifting a thousand gallons of water per second, and for raising the level of water in the old docks, were next visited and minutely inspected.

The members afterwards proceeded to the Langton Graving Dock and saw the 100-ton crane in operation, the various features of the tremendous instrument and the other adjuncts of the dock being explained by Mr. Lyster, Jun., and Mr. Le Mesurier, of the engineering department of the Dock Board. At the Langton Dock the members embarked on the Dock Board steamer *Vigilant*, where they were received by Mr. M. A. Sweeny, the marine surveyor, and went for a sail on the river, being thus afforded a comprehensive view of the extensive shipping trade of the port. Luncheon was provided by the Dock Board on board the *Vigilant*. Disembarking at Birkenhead the lairages were visited, under the guidance of Mr. Thompson, and the members were permitted to see how cleanly and expeditiously the slaughtering of several thousand foreign cattle is carried out. Mr. Thompson stated that as many as 700 cattle had been landed from a steamer into the lairages in 20 minutes, and as many as 2137 head of cattle and 2000 sheep slaughtered in a single day. Re-embarking on the *Vigilant*, a pleasant visit was made to the training ship *Indefatigable*, and an interesting inspection made of the interior of the vessel. This was followed by a visit to the *Servia*, one of the Cunard Atlantic liners, where tea was served in the saloon.

After tea, the President proposed a vote of thanks to the gentlemen who had accompanied the members of the Association, and given explanations of the different works visited; he said:—I think our thanks are due to Mr. Le Mesurier, the engineer of the Dock Board, who has done all that he could to make our visit a pleasant one. We must also thank Mr. Lyster, Jun., who looked after us so well while we were on shore; and also our thanks are due to Captain Sweeny who undertook our navigation so ably. Our thanks are further due to the Cunard Company, for having given us an opportunity of seeing one of these magnificent ocean greyhounds. I think we shall all remember our visit to the Mersey this day.

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The vote of thanks having been accorded with acclamation, Captain Sweeny suitably acknowledged the informal vote of thanks.

The *Vigilant* afterwards steamed to the Woodside Ferry, where the majority of the members disembarked and inspected the Mersey Tunnel, under the charge of Mr. W. Rowlandson, the resident engineer, and the remainder returned by steamer to Liverpool.

On Saturday morning, June 28th, the members assembled at the Municipal Offices, Dale Street, Liverpool, and drove to the Salt-water Baths, Pierhead, the oldest baths in the city of Liverpool.

(2.) *The Highfield Street Station of the Liverpool Electric Supply Company, Limited.*

The members then proceeded to the offices and works of the Liverpool Electric Supply Company, in Highfield Street, where they were received by Mr. Holmes, the chief engineer of the Company.

The station has machinery capable of supplying seven thousand 16 candle-power incandescent lamps. The plant is divided into sections, each consisting of one Lancashire boiler, 28 feet by 7 feet 6 inches, fitted with mechanical stokers, steam pressure 120 lbs. per square inch; one Willan's high speed compound engine indicating 180 horse-power at 350 revolutions per minute; one compound wound dynamo giving 120 volts and 900 ampères at 350 revolutions, coupled direct to the crank shaft of engine, and carried on same bedplate. The current is supplied to the consumers at a pressure of 110 volts, all the feeding mains being in simple parallel, and the pressure in each pair being regulated from the station. A pair of pressure wires run back from each distributing point to the station, where the pressure is continuously registered on a recording voltmeter. Accumulators are fixed at the station, having a supply capacity of one-tenth of that of the dynamos. By this means the current, after 12 midnight, is supplied from the accumulators, and the engines are stopped till the following morning at 8 A.M. The underground mains are run in iron troughs, in which they are supported on wooden saddles, and entirely surrounded by bitumen, with which the troughs are filled. Suitable distributing boxes are fixed at intervals on the under-

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ground mains, and contain fusible cut-out strips for each pair of service lines. The service lines to the consumers' premises are lead-covered cables, run in wood troughs, and covered with bitumen. The service lines are carried through walls in earthenware tubes, and terminate at a double-pole-switch and cut-out on the consumers' premises. Specimens of the above system of mains, boxes, and service lines, were exhibited. Attention was invited to a street lamp, fitted with a 500 candle-power incandescent lamp, and also with two 16 candle-power lamps, the latter for use after midnight. The Hookham electricity meter was shown, and its action explained. Diagrams were exhibited showing—(*a*) The increase in the number of lamps supplied by the Liverpool Electric Supply Company, from 1000 lamps in January 1888 to 8000 lamps in June 1890. (*b*) The variation in the output of a station at different hours of the day and periods of the year, the demand on the machinery at the hour of maximum demand in November being twelve times greater than in June. (*c*) A sliding scale of charges as used in Liverpool; the electricity required to run the consumers' lamps 100 hours per quarter being charged at 12*d.* per unit, the second hundred hours at 8*d.* per unit, and any further quantity at 4*d.* per unit. The test room and apparatus used by the Corporation Electric Inspector were examined, and the methods used explained by the inspector.

Before leaving the works, the President, speaking on behalf of the members of the Association, said:—I desire to thank Mr. Holmes most cordially for the reception he has given us to-day, and what he has shown us. He has laid everything open for our inspection, and he has given us the most lucid explanation of everything. In addition to that, he has fitted up some of the cables in the engine room, to show the method of laying them in the public streets, and done everything in his power to make the visit an instructive one.

(3.) *The Liverpool Hydraulic Power Company.*

A visit was next paid to the pumping station of the Liverpool Hydraulic Company, in Athol Street, where the members were received by Mr. F. M. Evanson, the resident engineer and manager.

This Company has been established to supply motive power to the public from street mains on the high-pressure hydraulic system. The Company has been in successful operation for the past two

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years in Liverpool, and is supplying a large amount of hydraulic power for various purposes with the most economical and satisfactory results. Allied companies have been working for six years in London, and for fourteen years in Hull. For lifting purposes, hydraulic power is peculiarly adapted; at the docks and goods stations hydraulic lifting machinery is universally employed, and also in many large wharves and warehouses; but it is only since the public supply has been given by the Company that the advantages of hydraulic power could be obtained at a reasonable cost by small consumers. The advantages offered by the Company's system are, however, by no means confined to small consumers; for in very few instances is the amount of power required by any individual firm or company so great that the use of the public hydraulic pressure will not effect a considerable saving. Although for lifting purposes hydraulic power is unquestionably far superior to any other, yet it is not in connection with this branch alone that it now stands pre-eminent. For working presses of all kinds, for example, its utility is obvious, as no pumps are needed. The power can also be applied to drive pumps and general machinery, and can be used for driving dynamos for electric lighting, &c. As a means of extinguishing fires, the public service it is capable of effecting is so great that it has been proposed to establish the system in towns with this object only. Passenger lifts of the most modern and improved types can be erected and worked from these mains at a greatly reduced cost. When hydraulic lifts have been provided, upper floors previously tenantless have been at once let at good rents, the advantages of obtaining a better light and air, and the greater quiet of the upper floors being eagerly sought after by tenants. However great the amount of work required to be performed, and for which the power is available, it is unnecessary for private firms, within the Company's districts, to have any steam engines, boilers, chimneys, steam pumps, gas engines, tanks, or skilled attendance on the premises. Much valuable space is also saved. The Hydraulic Power Company's system is equally well adapted for the smallest hoist or crane at present worked by hand only two or three times a day, and for the largest installations. The cost of the power, whether for a small or large plant, is in direct proportion to the work done, there being practically no standing expenses. There is no work of an intermittent character, such as lifting or pressing, too small or too large for the Public Hydraulic Power.

Upwards of twelve miles of mains are already laid, and further

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extensions are being rapidly proceeded with in the central districts of the city, so that power will now be available for passenger lifts, or for other purposes, in all the principal buildings.

The pumping station is situated in Athol Street, on the banks of the Leeds and Liverpool Canal, and the mains are kept charged by powerful pumping engines. The reservoir of power consists of capacious accumulators loaded to a pressure of 750 lbs. per square inch, thus producing the same effect as if large supply tanks were placed at a height of about 1600 feet above the street level. The power is available day and night, and on Sundays (if required), all the year round, at a pressure of 750 lbs. per square inch; a pressure which enables small machines to perform a large amount of work with a very small quantity of water. The progress of the London undertaking is illustrated by the number of gallons of water power delivered and machines at work during—

	Gallons delivered per week.	Number of Machines.
July, 1884	363,000	96
„ 1885	977,000	235
„ 1886	1,380,000	387
„ 1887	1,773,000	527
„ 1888	2,377,000	720
„ 1889	3,317,000	912
Jan., 1890	3,680,000	1022

In Liverpool, also, very good progress has been made, and more especially so during the last two or three months, since the difficulties with the Corporation have been satisfactorily settled by an arrangement whereby the Power Company has been granted facilities for extending its mains to any premises situated within the Company's district where power may be required. At the present time there are nearly 250 machines at work or contracted for, and the quantity of pressure water pumped is now about 700,000 to 800,000 gallons per week.

The mains in public streets are laid at the Company's expense, the service pipes only being charged to the consumers; and where it is desired, machines will also be provided, for which payments can be made either by deferred instalments or otherwise, as may be arranged. For a small annual sum the Company will undertake the inspection and adjustment of machinery worked from its mains.

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Where the power is required at some distance from the existing mains, special arrangements, involving only a small and temporary additional rental, are made for its supply, and the Company will lay special mains, without extra charges, where the use of the power is guaranteed of sufficient amount. The quantity of water used is measured through a meter, like gas; the consumer, by this arrangement, merely paying for the power actually expended. The amount payable for all the consumptions between 4000 (the minimum quantity) and 300,000 gallons per quarter, are given in a table, so that the accounts rendered can be compared at once therewith. There is a *minimum quantity* of power water, namely, 4000 gallons per machine per quarter. For example:—

	Gallons per quarter.	Charge per quarter as per Schedule.
		£ s. d.
Minimum for 1 machine	4,000	2 0 0
„ 2 „	8,000	3 0 0
„ 3 „	12,000	4 0 0
„ 6 „	24,000	7 0 0

There is a charge for rent of meters, in addition to charges for power water, which is approximately 5s. per machine per quarter, which includes the necessary inspection and maintenance by the Company's officials. In some cases the cost of lifting by the Company's power is as low as one farthing per ton lifted fifty feet high, and in all cases it is the *most economical power* that can be employed in lifting and pressing operations. The first outlay for hydraulic warehouse hoists, &c., is very much less than for gas engines of equal power, and, of course, also very much less than for steam engines and boiler, &c. The Company's pressure is available for fire extinction through hydrants specially constructed. An injector fire hydrant is the best means of utilising the power for this purpose. This hydrant is connected to the power mains and also to the water supply mains, and a combined jet of great force and volume is passed through the ordinary hose and nozzle, the hydrant increasing the pressure given by the waterworks supply to any required amount.

The PRESIDENT said: I should like to say, on behalf of the Association, that we thank Mr. Evanson for the opportunity he has given us to-day of seeing these works. We have seen a transmission of power which has come into force quite lately, which

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enables people to have power delivered at their doors in a remarkable manner. It is a new growth. It is not only an engineering success, but I believe I am right in saying it is a great financial success, and I hope that financial success will continue. We are on the best of terms with the company; and I think all present can understand that, when they see the manner of man Mr. Evanson is, no trouble whatever is given to the authorities, and I thank Mr. Evanson for his kindness to-day.

Mr. EVANSON briefly acknowledged the President's remarks.

The members then drove to St. George's Hall, and in the Crown Court—

Mr. MCKIE proposed a hearty vote of thanks to the President for his kindness, and for the hearty reception which he had accorded to the members on their visit to Liverpool. He also referred to the great exertions which the President had made to get through his evidence before the Parliamentary Committee so as to be able to be present at all their meetings.

Mr. C. JONES, in seconding the vote of thanks, said that had been the most interesting and instructive session the Association had ever held.

Mr. ASHMEAD (Bristol), as the senior Past President present, supported the vote of thanks to Mr. Boulnois, and it was adopted with acclamation.

The PRESIDENT, in acknowledgment, said: I thank you most heartily for the vote of confidence, if I may call it so. I have been on my trial, and I hope I have been acquitted of all blame of not making this meeting a success. You all understand I have been very closely engaged before a Parliamentary Committee, and all members who have been through that ordeal will imagine that I should prefer to be here rather than there. Fortunately, I got through my cross-examination in time, and I hope with satisfaction to the city, and was able to be here. I was most ably helped by every body, by my assistants in my office, and by all the members at this meeting. Wherever we have been in Liverpool we have been most cordially received; we have been able to see everything that it was possible to be shown at the different works we have visited, and I hope the members who have been present at those works have profited thereby. I thank you very heartily, and so long as I am your President I shall endeavour, as in the past, to continue in the future to have the interests of the Association very dear to me.

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(4). *The Royal Infirmary.*

The members then proceeded to the new Royal Infirmary, which is approaching completion.

In order to arrange the plan of the new Royal Infirmary in accordance with modern requirements, a greatly enlarged site was absolutely necessary. This has been obtained by absorbing the narrow street called "Pembroke Gardens," and purchasing a large strip to the north of it. The enlarged site covers the greater part of the space between Pembroke Place, Dover Street, Ashton Street, and Brownlow Street. Advantage has been taken of the 184 feet frontage to Pembroke Place for the administrative block. This at once strikes the keynote to the general arrangement of the building. On the south of the administrative department a wide corridor leads to one at right angles to it, running east and west. The wards are arranged in six blocks, three on either side of this latter corridor, giving a total of 290 beds. Where the two corridors join is placed the principal staircase, and the two principal lifts. The wards of the first floor are for females, and those on the second floor for males. The oblong wards to the south-east and south-west, on the second floor, take 32 beds each. On the first floor they are curtailed, to give space for small pay-wards, and rooms for sick nurses in the south-east; and for operation rooms in connection with the "Thornton," or Obstetric Ward, in the south-west block. All the wards have a scullery, a sisters' room, a doctors' room, a separation room for two beds, a dining or convalescent room, and a receptacle for patients' clothes. Two of the north wards are circular, and contain eighteen beds on each floor. The lecture theatre on the ground floor, and the operating theatre, with a top-light, on the first floor, are placed between the north-east and north-central wards. The Out-Patients' department is situated between the administrative block and the main building, and is approached on the west side of the administrative block through an archway. On the west side is a range of doctors' rooms with dressing rooms attached. At the end of the department are the dispensary and drug stores, which communicate also with the main building at the foot of the staircase. The laundry and mortuary are on the south-east side of the hospital, and have been most carefully considered. To the south of the laundry the existing Nurses' Home has been retained, while a new covered way gives it a sheltered communication with the

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hospital. The chapel is at the west end of the main ground floor corridor, and a large recreation hall, on the same floor, is contrived underneath the south central ward. The administrative block is devoted, on the ground floor, to business offices, on the first floor to the officers of the staff, on the second floor to nurses and lady superintendents, on the third floor to maidservants, and on the fourth floor to the kitchens and their adjuncts. A tramway runs direct from the kitchens to the head of the lifts in the centre of the building. The new Infirmary is to be erected of local grey brick, with dressings of red Ruabon terra-cotta, the roofs being covered with Westmoreland slates. Glazed bricks will be largely used in the interior. The floors will be of oak blocks, laid on concrete. The drainage of the building has been most carefully considered, being placed under the special care of Mr. Rogers Field, C.E., in conjunction with the Architect, A. Waterhouse, R.A. The heating of the building will be by steam generated in boilers placed under the laundry, though not to the exclusion of fireplaces. The radiators will be in the centre of the wards, supplied with fresh air from channels passing under the floors and open on both sides. The open fireplaces are placed against smoke and ventilating stacks also in the centre of the wards, the heat of the fires thus accelerating the removal of the vitiated air. The contract has been let to Messrs. Holme and Green.

(5.) *The Walker Engineering Laboratories*

Consist of a building of three stories, attached to another of one story, the latter being the wood-working department, which was completed and opened about a year ago. The main building consists of three floors, and is built in terra-cotta and grey brick, of which the whole of the future college buildings will be constructed, and of which the new infirmary, as well as the chemical laboratories, are already built. In order to assist the visitor in viewing the building completely, it will be well to describe the various features, in order to take the course of inspection best suited for the purpose. The visitor enters by means of a fine arch of terra-cotta work of Norman character, and finds himself in a vestibule at the foot of a few steps leading to the main entrance of the hall, separated from it by means of a screen of folding doors. Granite columns support arches through which the visitor passes into the hall, which is spacious, the walls being decorated with

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faience work, and the floor paved with a mosaic pattern of simple though elegant design. Here stands a full-length marble statue of H.R.H. the late Duke of Albany, by Count Gleichen, presented by Sir Andrew Walker. To the right is a balcony looking over the main laboratory, and arranged so that the work going on may be seen by visitors without the necessity of entering the laboratory itself. Passing straight onwards, on the right is a passage leading by stairs to the porters' rooms, and on the left is the cloak room and dressing room of the students, which is lofty, and has an iron gallery running around it, on which are lockers for coats and clothes suitable for workshop use. Descending a few steps, immediately in front of us is the wood-working department, separated from the main building by a fireproof door; while to the right, there is a side door through which the larger laboratory can be entered. The first object which strikes the attention is the imposing testing machine, manufactured by Messrs. Buckton, of Leeds, and capable of not only breaking a specimen by the force of 100 tons, but, by means of a special contrivance by which the position of the centres can be altered, of testing equally the finest and most delicate work. Passing around the testing machine, opposite the office, is seen a milling machine, for cutting iron and steel, which it may be remarked is a tool now taking a very important place in engineering workshops. Near it is a planing machine, and beyond, a number of lathes by the best makers, together with other similar machines, amongst which are a cutter grinder, a grindstone, &c. In this corner (that is to say, in the corner farthest from the door which the visitor entered) is a fitters' bench, and the lockers for the students' tools; while by means of an iron circular staircase, ascent can be made to the floor above. At the end of the laboratory is the dynamo for generating the electric current by which the main building can be lighted, which is driven (in common with all the machinery in the place) by means of a vertical engine of 40 horse-power. This engine actuates the main shafting, which runs along the centre of the laboratory, and gives motion to the counter-shafting of the various machines, and can be seen above, on the other side, attached to the main girders. Above, also, may be observed the travelling crane, which can be moved from one end of the laboratory to the other, and with its assistance an amount of experimental testing and other work can be done, which a comparatively small staff might be unable otherwise to accomplish. Near the vertical and smaller

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engine is a larger experimental engine, which develops 150 horse-power. This engine, which is on the triple-expansion principle, has been manufactured by Messrs. Forrester & Co., of this city, and they have spared no pains to make it one of the most perfect specimens of the kind. It has been designed specially and solely for experimental work, and by its means it is hoped that, not only will students be enabled to be taught in a thorough manner the theory of the steam engine, the manner of testing it, and taking indicator diagrams, but also many other measurements can be conducted which cannot be made in ordinary practice, and elaborate experiments may be carried out upon various points which are at present matters of discussion and difference of opinion in the engineering profession. Near this engine is a larger lathe, as well as a shaping machine and a drilling machine, all of which are of the most modern construction; and also a Worthington pump for hydraulic experiments. Over the two engines is another smaller travelling crane, which will be invaluable for purposes of examination, experiment, and change of pipes, &c., for the larger engine is arranged so that it can be converted into machines for presenting no less than *sixteen types* of engines. We now, through the door by the experimental engine, enter the boiler house. Here, on the right of the door, is the small forge and anvil, and beside it one of the experimental tanks; while against the wall is the boiler for driving the smaller laboratory engine, which is of the locomotive type. In the corner near it is a furnace for melting brass and iron. The floor extends only over a portion of the boiler house, and on the side where it is not carried is fixed the large marine experimental boiler, the mountings of which rise above the level of this floor. The boiler, which is of $\frac{7}{8}$-inch steel plate, is of special construction, and has been tested by hydraulic pressure to 400 lbs. on the square inch. Beneath the floor are the coal bunkers, and the three furnaces by which the whole building is heated by a high pressure hot-water system, by Messrs. King, of this city. A temporary passage has been made across to the farther entrance of the wood-working department, and the visitor on entering by it sees a room 100 feet in length, in which is a range of carpenters' benches, and running along the wall, a row of ten wood-working lathes driven by means of a 12 horse-power gas engine. This gas engine (which is enclosed in a pitch pine structure with glass sides) also actuates the general joiner, which consists of a circular-saw, wood-planing machine, &c., and other wood-working tools, such

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as a band-saw, hand-planer, and emery grinding machine; also a dynamo by which the whole of the carpenters' shop is lit by electric light. There are various other smaller machines visible; and the visitor, passing to the other end of this department, and by the office, again arrives at the main hall, through the fireproof door, and ascends the broad stone staircase, which is, like all the rest of the building, lighted either by electric light or gas, by means of a special arrangement of compound gas and electric light fittings, and arrives at the museum, in which are already some cases, although at present it has but few models as specimens. This museum, it is hoped, will be of great importance as an educational feature, not only for showing models of what has been done, but also specimens of examples of corrosion or fracture, or the effects of wear and friction, as also examples of the various materials used in engineering construction. Such museums have not at present been made a sufficiently important feature of English engineering colleges, although occupying a very important place in such institutions abroad. From the museum the lecture hall is reached, which has been most elaborately fitted—the arrangements of the black board and lecture table being worthy of examination. The hall itself is found to have acoustic properties of an excellent order, and there are separate desks for 130 students. The fittings of the hall are pitch pine and teak, and the roof bears evidence of skilful designing on the part of the architect (Mr. Alfred Waterhouse, R.A.), as well as of the excellent work generally observable on the part of Messrs. Brown and Backhouse, the contractors. Passing through the lecture hall we come to the apparatus room, where models for lectures are made; and next to it a large class room, and next to this the professor's private room, and the assistants' room next to it, which forms a convenient ante-room. Adjoining the latter is the head of the circular staircase previously mentioned, from which coign operations in the laboratory may be overlooked when necessary, and ready access gained to the ground floor. Passing down the passage (which goes under the raised slope of the lecture hall), we come again to the end of the museum, and proceed by a staircase on to a mezzanine floor, from which the upper tier of seats of the lecture hall is reached. This floor overlooks the museum from a balcony, running along which is an ornamental railing. Ascending still further, we come to the top floor, and, turning to the right along the passage, find ourselves in the drawing hall. This fine hall occupies the whole width of the

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building, and is well lighted on north, east, and west, while the artificial lights consist of gas pendants of elegant design, but not, as in other cases, combined with electric light. The electric light here is arranged in the following manner: each student has a drawing table, and over each table (forty in number) hangs a separate electric light from the roof. Adjoining the drawing hall is the lecturer's room, through which we arrive at the private room of a second engineering lecturer, and emerge in a passage in which is a smaller class room, and also the students' room. Above this apartment, in a portion of the roof, is constructed a photographic room, and a room lighted by means of a skylight, where copies of engineering drawings and tracings may be made.

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APPENDIX.

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BLACKBURN CORPORATION WATERWORKS.

RAINFALL AT THE FOLLOWING STATIONS IN THE COUNTIES OF LANCASTER AND YORK.—*Gauge above ground* (see under).*

BY J. B. MCCALLUM, M. INST. C.E., BOROUGH AND WATER ENGINEER.

	LANCASHIRE.									WEST RIDING OF THE COUNTY OF YORK.					
*Gauge above ground.	ft. in. 60 0	ft. in. 30 0	ft. in. 6 0	ft. in. 2 6	ft. in. 2 6	ft. in. 1 0	ft. in. 1 0	ft. in. 1 0	ft. in. 4 0	ft. in. 1 0	ft. in. 1 0	ft. in. 1 0	ft. in. 3 1	ft. in. 2 6	ft. in. 2 6
DATE.	Blackburn. Waterworks Office.	Blackburn. Corporation Store Yard.	Blackburn High Level Pumping Station.	Blackburn. Witton.	Pleasington. Higher Farm Park.	Blackburn. Guide.	Daisy. Green.	Pickup Bank.	Hoddlesden.	Dunsop Houses.	Brennand.	Whitendale.	Cabin Hill.	Middle Knoll.	Baxton Fell.
	Elevation 436	Elevation 373	Elevation 600	Elevation 315	Elevation 232	Elevation 650	Elevation 969	Elevation 720	Elevation 680	Elevation 450	Elevation 820	Elevation 830	Elevation 1559	Elevation 1298	Elevation 1540
1889.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January.. ..	1·26	1·53	2·30	1·84	2·07	1·73	2·41	2·49	2·95	4·32	5·02	5·49	6·00	2·70	2·90
February ..	1·47	1·91	2·76	2·69	2·30	2·02	2·48	2·64	3·10	4·44	5·05	5·34	4·66	5·12	1·43
March	2·06	2·50	3·23	3·11	2·75	3·17	3·67	3·78	3·88	6·37	8·87	8·90	8·00	5·20	5·00
April	1·51	1·67	2·40	2·26	2·17	2·05	2·56	2·75	2·74	3·64	3·15	3·49	2·10	2·40	2·90
May	2·35	2·31	2·73	2·95	2·71	3·20	3·14	3·72	4·17	3·93	3·88	3·79	3·90	4·00	4·00
June	·80	·78	·74	·67	··68	1·01	1·14	1·08	1·23	1·76	1·61	1·52	1·00	1·40	1·30
July	2·32	2·51	3·08	2·97	2·61	3·15	3·39	3·81	3·78	3·38	3·99	4·07	3·70	4·10	3·60
August	3·59	5·59	5·98	6·56	6·85	5·89	6·74	6·70	7·13	9·54	10·79	10·39	11·30	10·10	8·10
September ..	3·45	3·31	3·90	4·22	3·67	3·79	4·93	4·51	5·46	6·51	7·39	7·99	6·70	5·40	4·40
October.. ..	2·35	2·68	3·21	3·34	3·50	2·91	5·29	4·29	4·63	6·36	7·17	7·75	5·90	7·10	6·60
November ..	1·68	1·78	2·72	2·31	2·40	2·03	3·03	2·60	3·26	2·84	3·30	3·26	3·50	2·98	2·28
December ..	2·42	3·21	4·03	3·81	3·73	3·27	5·57	4·26	5·01	5·97	6·56	7·80	7·50	5·82	4·86
TOTALS for 1889	25·26	29·78	37·08	36·73	35·44	34·22	44·35	42·63	47·34	59·06	66·78	69·79	64·26	56·32	47·37

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Blackburn Corporat on Waterworks—*continued.*

	Lancashire.									West Riding of the County of York.					
Gauge above ground.	ft. in. 60 0	ft. in. 30 0	ft. in. 6 0	ft. in. 2 6	ft. in. 2 6	ft. in. 1 0	ft. in. 1 0	ft. in. 1 0	ft. in. 4 0	ft. in. 1 0	ft. in. 1 0	ft. in. 1 0	ft. in. 2 1	ft. in. 2 6	ft. in. 2 6
DATE.	Blackburn. Waterworks Office.	Blackburn. Corporation Store Yard.	Blackburn. High Level Pumping Station.	Blackburn. Witton.	Pleasington. Higher Park Farm.	Blackburn. Guide.	Daisy Green.	Pickup Bank.	Hoddlesden.	Dunsop Houses.	Brennand.	Whitendale.	Cabin Hill.	Middle Knoll.	Baxton Fell.
	Elevation 436	Elevation 373	Elevation 600	Elevation 315	Elevation 232	Elevation 650	Elevation 969	Elevation 720	Elevation 680	Elevation 450	Elevation 820	Elevation 830	Elevation 1559	Elevation 1298	Elevation 1540
Rainfall in—	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1888	23·51	28·29	37·47	35·81	31·90	31·34	39·57	40·27	43·41	56·38	66·25	66·26	62·69	52·30	49·91
1887	19·39	22·92	29·46	28·30	25·42	26·05	30·96	32·13	33·50	45·21	46·80	47·88	43·94	36·69	30·68
1886	31·12	37·34	46·84	43·40	35·12	40·16	49·07	50·84	54·43	68·38	70·69	71·45	58·20	58·60	50·10
1885	24·30	29·59	36·41	34·57	28·98	32·74	42·86	44·72	48·35	57·17	59·05	57·25	50·70	47·50	41·10
1884	27·78	30·77	35·43	35·64	32·22	31·45	39·60	39·89	45·59	55·64	58·40	59·63	56·20	52·60	45·40
1883	32·77	35·99	44·83	43·82	39·05	40·29	49·39	50·06	56·14	62·83	66·14	69·95	60·20	63·80	52·60
1882	38·06	41·60	53·44	50·13	48·25	47·14	58·59	59·01	63·98	78·67	72·76	81·32	72·00	74·30	61·00
1881	31·45	..	42·23	40·55	41·45	41·23	49·93	55·05	..	69·46	63·29	66·90	57·10	57·20	52·80
1880	38·73	..	42·06	41·57	38·44	40·29	44·09	44·07	..	58·18	57·44	65·30	63·50	49·70	49·60
1879	32·66	..	..	35·36	35·66	35·62	40·53	..	..	..	..	..	..	..	..
1878	36·31	..	..	41·05	..	42·40	..	44·50	..	..	..	..	..	..	..
1877	58·22	..	..	59·23	..	59·80	..	70·50	..	..	..	..	..	..	..
1876	45·47	..	..	..	..	42·50	..	47·60	..	..	..	..	..	..	..

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of the	Premiums offered.	Remarks.
te an.		
3000	£150, £100, and £50.	Size of Council chamber, 57 feet by 35 feet. Area, 1995 superficial feet.
was . e To years the hly h erect then d giv presen	Five of £75, each successful competitor being required to send in complete designs. The Architect finally selected received a commission of 5 per cent. on cost of works.	Size of Council chamber, about 43 feet by 34 feet. Area, about 1462 superficial feet.
33,00n.	£200 (merging in 5 per cent. commission), £100, and £50.	This refers to the Council house, and not the Town Hall, which is simply used for meetings, &c. Size of Council chamber, 60 feet by 50 feet. Area, 3000 superficial feet.
32,00n.	1st, £120. 2nd, £80. 3rd, £60.	Size of Council chamber, 48 feet by 30 feet. Area, 1440 superficial feet.
22,00n.	1st, 5 per cent. on cost of building. 2nd, £100. 3rd, £50.	Size of Council chamber, 38 feet by 38 feet. Area, 1444 superficial feet.

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	Remarks.
	of Council chamber, 43 feet 28 feet 6 inches. Area, 25 superficial feet.
	Town Hall was erected arly 30 years ago, before town was incorporated, l is not at all adequate for sent requirements. building was not carried t in accordance with the cessful drawings, but the chitect was employed to dify and alter his design a large extent.
	of Council chamber, 36 by 36 feet. Area, 1296 erficial feet.

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Commodated in	ed.	Remarks.
..		This building is very good in most respects, and much admired as a handsome structure.
£88pector, the	£100.	Size of Council chamber, 37 feet 6 inches by 37 feet, with an alcove 19 feet by 9 feet 6 inches. Total area, 1568 superficial feet.
luding gas,		
ical Officer nding Libr Collectors		
ctures, tem		
Part Sessions, an	£50.	
Borough A rade, Comm 's residence isance Insp ion Survey nce and S oke Inspec age, gas tes		The Building was erected by the Corporation; the Borough Architect prepared the plans.
Courts and nine	ted to detail	Size of Council chamber, 55 feet by 31 feet (exclusive of alcoves). Area, 1705 superficial feet.
Abclerk's, Bor	£50.	
School Bo lice Court a rooms, Fire tendent of us, Caretak		
Corpor, Medical	£50.	Inadequate for present requirement.
rn Market, Chamber,		
s, Committe	£100.	The premium merged in the commission of the authors of the premiated designs, who were employed to carry out the work.
ngineer, Bo Department Auditors'		
n the repo dations of		
Nchamber,	60.	
office, Poli ices, Cells,		

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Remarks.

g committee saw
wn Hall and liked
hat it has been re-
t Portsmouth.
ɔil chamber, 56 feet
Area, 1344 super-

g (an old one) has
ɔged and altered
es.

ıncil chamber, 10
feet.
ncil chamber, 2040
feet.

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VOLUNTARY EXAMINATIONS.

SYLLABUS.

THE ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS have undertaken the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

Two Examinations are held in each year; one in April, and one in October, in London.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects:—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Public Health Acts, and Rivers Pollution Acts.

Examples of the class of questions proposed to be asked under these heads are appended hereto.

Candidates are allowed two hours to answer the questions under each of the four heads, and are not necessarily required to answer all the questions set in each paper, though not less than four must be taken: marks are given for all questions properly answered. The *vivâ voce* examination is held after the written papers have all been sent in, and is directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations extend over one or two days, as circumstances may require, and in the latter case the arrangements will be, as far as possible, as follows:—

First day	.. 10	to 12	..	Engineering.
„	.. 2	„ 4	..	Building Construction.
„	.. 5	„ 7	..	Sanitary Science.
Second day	.. 9.30	„ 11.30		Public Health Law.
„	.. 1	„ 4	..	*Vivâ voce* Examination.

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The total number of marks required to constitute a pass is 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

The fee for each Examination is 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he will be entitled to present himself again at the next, or any subsequent Examination, on payment of one-half of the above fee.

No further charge will be made to the candidate than the fees above mentioned.

Candidates that do not present themselves for the Examination forfeit the entrance fee.

Successful candidates are entitled to receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thos. Cole, Secretary to the Association, 11, Victoria Street, S.W.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work:

A. Land Surveying and Levelling.
B. Hydraulics.
C. Drainage and Sewerage.
D. Water Supply.
E. Road Making.

II.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.

III.—Sanitary Science as applied to Towns and Buildings:

A. Ventilation.
B. Sewage Disposal.
C. House Drainage.

IV.—Public Health Acts.
Rivers Pollution Acts.

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EIGHTH EXAMINATION.

The Eighth Examination of candidates was held at the Offices of the Association, Westminster, on the 4th and 5th October, 1889, at which the following Examination Papers were set to the candidates.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner:—W. Geo. Laws, M. Inst. C.E., City Engineer, Newcastle-on-Tyne.

1. Sketch a small farm of three or four fields, and show where you would run your main lines to survey it, showing also what "tie" and "proof" lines you would measure.
2. Give a short description of a field level, and of its use in practice. Show why errors of collimation, and the error due to curvature, are increased in levelling on a slope, and may be neutralised by taking equal back and fore sights.
3. Explain the terms "Hydraulic Mean depth," and "wetted perimeter," and their relation to each other.
4. It is necessary to carry a main sewer across a small stream liable to floods: the invert level of the sewer and ordinary water level of stream are alike. How would you deal with the difficulty?
5. How would you, in draining a town, proportion the size of the sewers to area drained, and what are principal factors to be considered?
6. Specify, shortly, for laying a 5-feet brick sewer 20 feet deep, in doubtful ground, where you have reason to expect water.
7. What proportion of the rainfall (average say 30 inches per annum), would you calculate on impounding in hill pasture districts, where the ground varied from 700 feet to 1800 feet above sea level?
8. State what you know of Deacon's system for the detection of waste in the water service mains of the town.
9. Describe and sketch a "Macadam" road, and compare it with the "Telford" road, noting the points of difference.
10. What paving would you advise for the streets of a manufacturing town, where the traffic was rather heavier than an average? Specify for it.

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SUBJECT:—BUILDING CONSTRUCTION, &c.

Examiner:—A. M. Fowler, M. Inst. C.E., Borough Surveyor, Stockport.

"A.—MATERIALS."

1. State the component parts of Concrete, viz.:—
   Cement Concrete.
   Lias Lime Concrete, and
   Ordinary Lime Concrete.
   Specify the test which should be applied to the Cement and the Limes. How the same should be mixed and applied to the work, and what they are most suitable for.
2. In applying Wrought Iron Girders and Cast Iron Columns for the support of walls or floors with a bearing of 30 feet, and supporting a safe load of 45 tons equally distributed; give a sketch of the girder and specify shortly how the metal should be put together, stating the tensile strain per square inch to which the metal should be tested without fracture. State the thickness of cast-iron columns for rooms 16 feet high to support the above. State how the metal should be made, and the test you would apply for cast iron.
3. State the class and qualities of Timber most suitable for outside and inside work, viz., window frames, doors, joists, floor boards, roof framing, and plaster laths.
4. Specify the quality and workmanship of Plaster for ceilings, walls, and cornices, giving the trade terms.

"B.—CONSTRUCTION."

5. Give a sketch, plan, and longitudinal and cross section of a public Platform for viewing public demonstrations, to seat about 500 persons, marking thereon the scantlings of the timber and foundations, and the mode of framing the timbers.
6. Give a sketch of a warehouse 100 feet long, 30 feet wide at one end and 20 feet wide at the other, four storeys 14 feet high each; figure the thickness of the walls, and state the mode of constructing the same fireproof, how the roof should be framed, showing the eaves and sky line in elevation.
7. Describe how the outer walls of a dwelling house of the first class, three stories high, should be built if faced with stone. Give a sketch of a cross section of the wall, showing the bond, footings, and termination under the eaves; ventilation, and the precautions to prevent damp rising.
8. State how you would form valley gutters of lead. How would you apply it at the joining of roofs with chimney stacks, skylights, giving the weight per square foot necessary, and a sketch showing arrangement of fall in the gutter, specifying the trade terms and construction?

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SUBJECT:—SANITARY SCIENCE.

Examiner:—Charles Jones, A. M. Inst. C.E., Surveyor to the Local Board, Ealing, W.

1. Give the principal clauses in the Model Bye-Laws relating to the Ventilation—
   (*a*) Of Buildings—Interior.
   „ Exterior, space at rear, &c.
   (*b*) Streets—Widths, Exits, &c.
2. Describe (with sketch) the best mode of Ventilating House Drains.
3. Ditto „ „ „ Sewers.
4. Give a description of the best form of w.c., together with the Flushing and Ventilating arrangement connected with same.
5. Describe generally the "Milk of Lime" process—its suitability or otherwise for treating Town Sewage—and the grains per gallon required when used alone or in combination with other chemicals.
6. State under what circumstances the application of Sewage to Land may be desirable—and give some details as to its application—either as Raw Sewage or a Clarified Effluent.
7. Describe the best methods of dealing with the Sludge.
8. State briefly the general principles to be observed in the preparation of a scheme for the drainage of a town of 25,000 inhabitants.
   (*a*) When the town presents almost a dead level.
   (*b*) Where moderate but sufficient gradients can be obtained.
9. Describe the best method of Flushing the Sewers of a town under the preceding (*a*, *b*) conditions.
10. State briefly the arrangements necessary to the efficient drainage of a good middle-class dwelling house.
    (*a*) Detached Villa.
    (*b*) One of a Terrace.
    (Sketch of above, *not to scale.*)

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner:—W. Santo Crimp, Assoc. M. Inst. C.E., F.G.S., M.S.I., Surveyor to the Local Board, Wimbledon.

1. What is the difference between a "drain" and a "sewer"?
2. Define the duties of a local authority with regard to the sewers belonging to them.
3. The owner or occupier of any premises within the district of a local authority is entitled to cause his drains to empty into the sewers of that authority upon observing certain conditions. Define those conditions.
4. What steps must a local authority take before commencing sewerage or sewage works without their district?

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5. Define the principal subjects with regard to which an urban authority may make bye-laws.
6. What Acts are wholly or in part incorporated with the Public Health Act for the purpose of enabling any local authority to supply water within their district?
7. Existing cellar dwellings are only to be let or occupied on certain conditions. Define those conditions.
8. Under certain circumstances, notice to abate a nuisance must be served upon the owners of the premises. Define those circumstances.
9. What steps must a local authority take before serving notices to make up a road under the 150th section of the Public Health Act?
10. In what manner, and under what Act, may ruinous or dangerous buildings be dealt with?
11. What is the main object of Part II., Section 3, of the Rivers Pollution Prevention Act, 1876?

Ten candidates presented themselves for examination, of whom the following six satisfied the Examiners, and were granted their certificates of competency:—

Aspinall, M. (Cardiff).
Bucknall, H. (Stratford-on-Avon).
Gaffney, F. S. B. (Athleague).
Noakes, H. S. (Tunbridge Wells).
Preston, T. (Bradford).
Thomas, T. (Neath).

NINTH EXAMINATION.

The Ninth Examination was held at the Institution of Civil Engineers, Westminster, S.W., on the 18th and 19th April, 1890, when the following Examination Papers were set to the Candidates.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner:—J. Lobley, M. Inst. C.E.

1. Plot the accompanying levels for a section of a new street. Horizontal scale 1-500. Vertical scale 1-50. From the kerbstone at A plot on section the intended finished surface rising from A at a gradient of 1 in 49. Compute the amount of excavation in cube yards, allowing for a depth of 6 inches for macadam and 12 inches for foundation of rock, &c. The width of street is 20 feet between the channels.
2. Show on the accompanying Plan the main lines and ties you would chain in surveying the streets. Describe any angles you think should be taken by a theodolite.
3. Explain how you would extend a straight line for Surveying purposes, such as laying out a new road over a hill—both with and without a theodolite.
4. Give a ready means of measuring the height of a factory chimney where access can be had to the ground at its base.

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5. State under what circumstances circular sewers are preferable to egg-shaped, and *vice versâ*.
6. Describe briefly the leading principles of the following systems of sewerage:—(1) Ordinary, as in London. (2) The separate provision for rain, as in Reading. (3) Capt. Liernur's. (4) Mr. Shone's.
7. In the first of the above systems, what amount of rain is it necessary to provide for? Give the amount in gallons at the outfall in 24 hours for an area of 2000 acres.
8. State the nature of the provision to be made for rainfall exceeding the amount stated in the preceding answer.
9. A 15-inch pipe sewer, 200 feet long, with a fall of 1 foot, is considered sufficient to drain a certain area; what extra depth would the sewer have to be laid at its lower end to enable a 12-inch pipe sewer to discharge about the same quantity of sewage?
10. State the capacity in gallons of a tank 200 feet long, 40 feet broad, and 10 feet deep. Also of a tank 16 feet long, 13 feet broad, and 11 feet deep. State the pressure in each case per square foot on the bottom.
11. A water main descends from a reservoir A delivering water to a building at B, passes across a valley at C, and rises on the opposite hill side, supplying building D. A is 300 feet, D is 93 feet, B is 171 feet above C; calculate the water pressure per square inch at each point, B, D and C, disregarding friction and distance.
12. Sketch a cross section of a street 50 feet wide with heavy traffic—showing proper proportion of footpaths and short specification of all work necessary, excluding excavation.

Subject:—Building Construction, &c.

Examiner:—James Lemon, M. Inst. C.E., F.R.I.B.A., F.S.I., F.G.S.

Materials.

1. Describe the following materials for a Warehouse:—

Concrete.	Lime.	Stone.
Bricks.	Cement.	Iron.

2. Write a brief specification for the following work:—
   (*a*) Slater—Countess slates.
   (*b*) Plasterer—Walls, Partitions, and Ceilings.
   (*c*) Plumber—Watercloset outside, and superior ditto inside, with sizes of pipes.

Construction.

3. What size of timbers would you specify for a floor 16 feet by 12 feet, to carry a moving load of 1 cwt. per foot super; the mode of calculation to be shown.
4. Draw a sketch plan of double framed floor, 24 feet by 18 feet, and give dimensions of timbers, moving load 1¼ cwt. per foot super.
5. Draw a cross section of a concrete floor, rendered with cement on top, and supported by rolled iron girders, the span of girders being 14 feet, the

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distance apart or span of arches, their rise, and thickness to be figured. The load to be carried by floor 2 cwt. per foot super.

6. Draw a cross section of a kingpost roof for a 25 feet span, to rise one-third of span, and figure dimensions of timbers. Principals supposed to be 10 feet apart.
7. Draw cross section of iron principal for roof of 40 feet span; figure dimensions of rafters, struts, ties, &c. Principals supposed to be 10 feet apart.
8. What is the safe load on a rolled iron girder 12 inches deep, and area of flange 4 inches for a span of 16 feet; show the calculation.
9. Give the dimensions of a wrought or cast iron girder to carry a 4½-inch wall, 20 feet high, the span being 16 feet.
10. Show by a sketch, with figured dimensions, how you would shore up the front wall of a dangerous building, to prevent it falling into the street.

NOTE.—The Sketches need not be drawn to Scale.

SUBJECT:—SANITARY SCIENCE. (VENTILATION—SEWAGE—HOUSE DRAINAGE).

Examiner:—Charles Jones, A. M. Inst. C.E.

1. Give generally the best mode of ventilating:—
   (*a*) Middle-class dwelling house.
   (*b*) Public hall.
2. Give the chemical composition of a pure atmosphere.
3. Describe the best mode of maintaining a pure atmosphere in sleeping apartments generally; and any special apparatus suitable for lodging house and hospital.
4. Describe in general terms your views as to the treatment of sewage farms in a town where water carriage system only can be adopted.
5. Give four illustrations from personal observation of the work done upon sewage farms (name the farms).
   (*a*) Crops grown.
   (*b*) Financial results.
6. Describe three several systems of treating sewage other than by irrigation.
7. Sketch ground plan of modern villa, say 40 ft. frontage, with various offices, lines of drains and house connections.
   (*a*) Also section of same to one pair floor with bath room and lavatory.
   (*b*) Also sectional lines of drains, and describe the most approved mode of laying and jointing same.
   (*c*) Describe the best method of preventing the water supply from being contaminated.
8. Sewer gas having been discovered in a house, describe the best mode of testing the drain and discovering the defects.

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SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner:—T. De Courcy Meade, A. M. Inst. C.E.

1. Define the meanings assigned by the Public Health Act, 1875, to the words "Street," "House," "Drain," and "Sewer?"
2. What Sewers within the District of a Local Authority are not vested in and are not under the control of the Local Authority?
3. Four houses (A, B, C and D) are without drains sufficient for effectual drainage. A, B and C adjoin and are situated within 30 yards of an available public sewer. D is 40 yards from such sewer. What powers are given to the Local Authority to enforce drainage of these houses? If an alternative method is provided, state it.
4. State, generally, what powers Local Authorities have in relation to the supply of water for public and private purposes?
5. What powers are given to Local Authorities with respect to Mortuaries, removal of dead bodies, and places for Post Mortem Examinations?
6. What powers are given to Local Authorities to regulate the line of buildings in streets in Urban Districts?
7. What powers are given to Local Authorities as to making, or contributing to the cost of making, new Public Roads and constructing Public Bridges?
8. The Officer of Health finds premises (within a District to which the Artisans' and Labourers' Dwellings Act of 1868 applies) in a condition dangerous to health, so as to be unfit for human habitation. Describe the procedure under the Act of 1868, and assume that the owner of the premises disputes the decision of the Local Authority?
9. What are the requirements of the Model series of Building Bye-Laws issued by the Local Government Board under Section 157 of the Public Health Act, 1875, as to the height of rooms, and scantling of timber used in the construction of domestic buildings?
10. State the objects of the Rivers Pollution Prevention Act, 1876, and the sources of pollution defined by Sections 2, 3, 4, and 5? If you have any practical knowledge of the working of this Act, give your views as to its utility or otherwise, and state reasons for the conclusions you have arrived at.

Six candidates presented themselves, for examination, of whom the following four satisfied the Examiners, and were granted their certificates of competency.

Catchpole, J. H. (Hendon).	Miller, J. E. (Durham).
Gibbs, L. (Walsall).	Wood, J. W. (Rochdale).

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BOARD OF EXAMINERS.

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Borough Engineer, West Ham (Past President).

H. P. Boulnois, M. Inst. C.E., City Engineer, Liverpool (President).

W. Santo Crimp, Assoc. M. Inst. C.E., F.G.S., M.S.I., Assistant Engineer, London County Council (Member of Council).

C. Dunscombe, M.A., M. Inst. C.E., late City Engineer, Liverpool (Vice-President).

E. B. Ellice-Clark, M. Inst. C.E., late County Surveyor, West Sussex (Past President).

A. M. Fowler, M. Inst. C.E., late Borough Surveyor, Stockport (Member of Council).

T. Hewson, M. Inst. C.E., Borough Engineer, Leeds (Vice-President).

C. Jones, Assoc. M. Inst. C.E., Surveyor to the Local Board, Ealing (Past President).

W. G. Laws, M. Inst. C.E., City Engineer, Newcastle-on-Tyne (Past President).

Jas. Lemon, M. Inst. C.E., F.R.I.B.A., Consulting Engineer, Southampton (Past President).

Jos. Lobley, M. Inst. C.E., Borough Engineer, Hanley (Past President).

T. De C. Meade, Assoc. M. Inst. C.E., Surveyor to the Local Board, Hornsey (Vice-President).

E. Pritchard, M. Inst. C.E., 37, Waterloo Street, Birmingham (Past President).

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CANDIDATES WHO HAVE PASSED THE EXAMINATION.

Date of Certificate.		
May 7, 1887	..	Adcock, C. (Liverpool).
May 1, 1886	..	Angell, J. A. (Leytonstone).
May 1, 1886	..	Ashmead, H. (Clifton).
Oct. 19, 1889	..	Aspinall, M. (Cardiff).
Oct. 16, 1886	..	Ball, G. (Scarborough).
May 12, 1888	..	Barnes, S. W. J. (Ealing).
May 12, 1888	..	Bayley G. H. (Salford).
Oct. 16, 1886	..	Beard, E. T. (Lincoln).
May 12, 1888	..	Beynon, J. C. S. (Exeter).
Apr. 13, 1889	..	Blizard, J. H. (Southampton).
Apr. 13, 1889	..	Bradley, J. W. (Burnley).
Nov. 17, 1888	..	Brown, R. R. (Bridlington Quay).
Oct. 16, 1886	..	Brownridge, C. (Leeds).
May 12, 1888	..	Bryans, J. G. (Sunderland).
Nov. 17, 1888	..	Bryning W. G. (Liverpool).
Oct. 19, 1889	..	Bucknall, Hy. (Stratford-on-Avon).
Apr. 13, 1889	..	Carter G. F. (Leeds).
May 3, 1890	..	Catchpole, J. H. (Hendon).
May 1, 1886	..	Coales, H. G. (King's Lynn).
Oct. 22, 1887	..	Cook, J. (Bury).
May 12, 1888	..	Cooper, C. H. (Wimbledon).
May 7, 1887	..	Cooper, F. E. (Liverpool).
May 12, 1888	..	Crow, A. (Stratford, E.).
Oct. 16, 1886	..	Crowther, J. A. (Leeds).
May 7, 1887	..	Dearden, Hy. (Leeds).
Apr. 13, 1889	..	Dixon, W. B. (Wolverhampton).
May 1, 1886	..	Fenton, W. C. (Sheffield).
Nov. 17, 1888	..	Field, W. C. (Eastbourne).
May 12, 1888	..	Finch, A. R. (Finchley).
May 7, 1887	..	Franks, T. W. (West Bromwich).
Oct. 19, 1889	..	Gaffney, F. S. B. (Athleague).
May 3, 1890	..	Gibbs, L. (Walsall).
May 12, 1888	..	Glass, S. N. (Hackney).
May 12, 1888	..	Gloyne, R. M. (Manchester).
May 1, 1886	..	Greatorex, A. D. (Toxteth Park).

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Date of Certificate.		
May 1, 1886	..	Harland, A. (London).
Nov. 17, 1888	..	Hawkins, I. T. (Chichester).
May 12, 1888	..	Houghton, J. (King's Heath).
Oct. 16, 1886	..	Jameson, M. W. (Leeds).
May 12, 1888	..	Lynam, G. T. (Barnsley).
Oct. 16, 1886	..	Mallinson, T. (Selby).
Oct. 22, 1887	..	Mellor, T. E. W. (Stockton).
Oct. 22, 1887	..	Metcalf, J. W. (York).
May 3, 1890	..	Miller, J. E. (Durham).
Nov. 17, 1888	..	Millington, J. S. (Wavertree).
May 12, 1888	..	Milnes, G. P. (Wakefield).
Apr. 13, 1889	..	Nettleton, H. (Leeds).
May 7, 1887	..	Nichols, A. E. (Leeds).
May 7, 1887	..	Nickols, F. J. (Leeds).
Oct. 19, 1889	..	Noakes, H. S. (Tunbridge Wells).
May 1, 1886	..	Osborne, F. (Dover).
Oct. 22, 1887	..	Parker, W. (Hereford).
Oct. 16, 1886	..	Pickering, J. S. (West Bromwich).
Oct. 19, 1889	..	Preston, T. (Bradford).
May 12, 1888	..	Pritchard, T. (Richmond).
May 7, 1887	..	Rich, E. W. (Hounslow).
May 1, 1886	..	Saunders, E. E. (Walthamstow).
May 7, 1887	..	Saunders, Jas. (Newark).
Oct. 22, 1887	..	Saville, R. W. S. (Accrington).
Oct. 16, 1886	..	Silcock, E. J. (Leeds).
Apr. 13, 1889	..	Stringfellow, W. (Southampton).
Oct. 16, 1886	..	Sykes, E. (Reddish).
Apr. 13, 1889	..	Taylor, W. J. (Southampton).
Oct. 16, 1886	..	Thomas, R. J. (Carnarvon).
Oct. 19, 1889	..	Thomas, T. (Neath).
Apr. 13, 1889	..	Tomes, G. B. (Eastbourne).
Oct. 16, 1886	..	Turner, V. H. (Leeds).
May 7, 1887	..	Verschoyle, B. (Liverpool).
Oct. 22, 1888	..	Ward, F. D. (Manchester).
May 12, 1888	..	Wilson, C. L. W. (Bacup).
Nov. 17, 1888	..	Wilson, J. B. (Cockermouth).
May 1, 1886	..	Witts, J. W. (Skelton).
May 3, 1890	..	Wood, J. W. (Rochdale).
Oct. 16, 1886	..	Young, Wm. (Pendleton).

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Memoirs of Deceased Members.

The Council, having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

It is with much regret that the Council have to chronicle the death of Mr. R. Vawser, Past President. The following, extracted by permission from the Minutes of Proceedings Inst. C.E., vol. xciv. p. 372, gives an account of Mr. Vawser's professional career. He was the third son of the late Mr. Charles Vawser, of Waldersea, March, Cambridgeshire, was born on the 13th September, 1841, educated at Peterborough, and afterwards articled to the late Mr. M. O. Tarbotton, of Nottingham, with whom he subsequently remained for a short period, being entrusted by Mr. Tarbotton with the carrying out of various important works. In 1863, Mr. Vawser entered the office of the late Mr. C. E. Cawley (sometime M.P. for Salford), of London and Manchester, under whom he designed and superintended various engineering works. In 1866, he left Mr. Cawley, having obtained the appointment of principal assistant to the Borough Engineer of Belfast, under whom he carried out public works of considerable magnitude, including the sewering and paving, in one year alone, of 130 streets. In 1867, Mr. Vawser was appointed Borough Surveyor of Warrington, where he designed and carried out many important works, including main-sewerage works, several miles of impervious pavements, an infectious disease hospital, art gallery, &c. In his letter of resignation, dated 22nd October, 1887, he stated that nearly ten years had elapsed since his pleasing association with the Council commenced,

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and that he should always remember with satisfaction that the Borough Surveyorship of Warrington was his first public appointment. Mr. Vawser commenced business on his own account in Manchester, immediately after relinquishing his appointment at Warrington, and soon acquired a large and lucrative practice, more especially in sewerage and sewage works, and at the time of his death was engaged upon important works at Swinton, Milnrow, Reddish, Tyldesley, Royton, &c. He did not, however, devote himself exclusively to sanitary engineering, and amongst other works was engaged upon the extensive system of tramways known as the Manchester, Bury, Rochdale, and Oldham Tramways, the Barrow-in-Furness Tramways, &c.

Mr. Vawser took an active interest in the Association of Municipal and Sanitary Engineers and Surveyors, his connection with the Association dating from its formation, when he began his services as honorary secretary for the Lancashire and Cheshire District. In 1875 he became a Member of the Council, in 1880 a Vice-President, and in 1885 President. During his presidency the examinations of candidates for municipal engineerships were instituted. Mr. Vawser always evinced the keenest interest in the affairs of the Association, largely contributing to its Proceedings, and his early death is deplored by the members generally.

Mr. Vawser was elected an Associate of the Institution of Civil Engineers on the 4th April, 1871, and was transferred to the class of Members on the 26th January, 1875. He died somewhat suddenly on the 15th September, 1889, after a long and painful illness.

JOSEPH GORDON, M. Inst. C.E., Past President, and, at the time of his universally regretted decease, an Honorary Member of the Association, was born at Haltwhistle, Northumberland, on April 16th, 1837. His limited scholastic education was begun and completed in that small Border town, where even thus early, he developed those features of resolution and perseverance which subsequently formed the key-note of his character, and in no small degree supplied the absence of what would now be regarded as the indispensable preliminary training for his adopted profession. In accordance with the evident bent of his own inclinations, he was articled, in 1852, to the late Mr. James Hogg, then City Surveyor of Carlisle, and thoroughly identified himself with every department of work in that gentleman's local and county practice.

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After an engagement of a few months as assistant to Mr. Thomas Fenwick, M. Inst. C.E., then Borough Surveyor of Tynemouth, Mr. Gordon accepted an offer made to him by Mr. (now Sir) Robert Rawlinson, in connection with the preliminary survey for extensive and difficult sewerage works at West Ham, Essex, and in 1858 was appointed Resident Engineer to carry out Mr. Rawlinson's comprehensive scheme. Having carried the works well towards completion, he applied, in 1860, for the vacant City Surveyorship of Carlisle, and, being elected, remained in that position for six years. Before entering on the duties of this, his first independent office, Mr. Gordon had definitely adopted the sanitary branch of engineering as his own, and was thus able to work out his matured and independent views in what he was wont to call the town of his first love. He was warmly and efficiently backed by the then Medical Officer of Health, the late Robert Elliot, M.D., who was emphatically a man in advance of his time in his knowledge of sanitary science, and to whose far-seeing optimism and unselfish zeal Mr. Gordon ungrudgingly attributed much of the success of his own excellent work in the city.

In 1864, the Borough Surveyorship of Wolverhampton being apparently within Mr. Gordon's grasp, the Corporation of Carlisle decided to retain his services by allowing him the privilege of private practice beyond the city boundaries. He was thus enabled to widely extend his experience in the preparation of sewerage and water supply schemes for various local authorities, in reports on various other matters, and in Parliamentary Committee work, for which his never-failing accuracy and unvarying completeness of preparation pre-eminently fitted him.

Early in 1866, Mr. Gordon yielded to the inducements offered him by the Municipality of Frankfort-on-the-Main to undertake the preparation of a sewerage scheme for that city, on the general lines laid down by a mixed commission of engineers and hygienic experts appointed in June 1863. The only English member of this Commission, Mr. William Lindley, M. Inst. C.E., had, many years previously, designed and carried out, at Hamburg, the largest works of that class then existent in Germany. The report of the Commission, issued in August of the same year (1863), being ultimately adopted, Mr. Lindley was retained as Consulting Engineer, and Mr. Gordon devoted nearly the whole of 1866 and part of 1867 in elaborating the main features of the scheme, no actual works being commenced until about the middle of the latter year, by which time

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the main lines and levels of the project as a whole had been definitely established and laid down. Closely following the commencement of the works, steps were taken to formulate stringent private drainage regulations, providing for the presentation, in every case, of fully detailed plans and sections based on the municipal datum, and in many other respects (such as the compulsory use of lead-jointed heavy cast-iron pipes under houses), going far beyond anything ever previously attempted in this department of municipal sanitation. The question of sewer ventilation, and its intimate correlation with that of sewer flushing, received a large share of attention at Mr. Gordon's hands, while his old habits of exactness and conscientious construction found a wide field for their application, with the result that the Frankfort works came to be regarded as models of their kind. Deputations from the chief cities of the Continent visited them, and even leading English engineers accorded a generous recognition of the merits of their design and the sterling excellence of their construction under Mr. Gordon's self-sacrificing and enthusiastic control. In six years about forty miles of the main works, and an equal length of private drainage, had been laid down, and Mr. Gordon, seeing an opening for consulting practice in Germany, relinquished his appointment in October 1873, declining the offer of a large increase of salary to remain in the service of the Frankfort authorities.

The works designed or advised upon by Mr. Gordon between 1873 and 1881, when he returned to England, embrace nearly all the large undertakings entered upon in Germany during that period as a result of the great sanitary movement to which the Frankfort works had given such an impetus. They included (in addition to smaller towns) the sewerage of Stuttgart, Heilbronn, Munich, Hanau, Nuremberg, Dortmund, Bockenheim, Landshut, Ludwigshafen, and Homburg, with an aggregate population of 600,000, and at a total cost, for main works alone, of at least 900,000*l.*

Owing to the claims of his family, Mr. Gordon had for some time been impressed with the desirability of his and their return to England, for which an opportunity was found in his election to the Borough Surveyorship of Leicester. On taking office, in March 1881, he quickly appreciated the extent and variety of the work before him, and devoted himself, with his accustomed energy, to the consideration of the abnormal sanitary conditions of the important area placed under his engineering control. Owing to

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the phenomenally rapid growth of the town, the original sewerage and sewage purification works had become inadequate to the demands upon them, while the frequently recurring floods and generally high level of the River Soar had long been recognised as injuriously affecting the health of the lower lying portions of the borough. Mr. Gordon devoted what may fairly be described as the best eight years of his life to the solution of the difficult problems thus laid before him, with a degree of success which has evoked the admiration not only of those immediately interested in the work, but of those who are specially qualified to express an opinion. At an unusually well-attended District Meeting of this Association, held in Leicester, in May 1884, Mr. Gordon read a paper on the Public Works of Leicester, and personally conducted those whose good fortune it was to be present over the flood works then in progress, besides lucidly explaining the lines upon which the remaining operations were to be conducted in accordance with his plans.—Mr. Gordon had, very soon after his return to this country, enrolled himself as a member of the Association, of which he became an active supporter and a frequent attender at its meetings.—In July 1887, at the Annual Meeting held in his own town, on the occasion of his installation in the Presidential Chair, the further developed works were inspected with enhanced interest by an even larger gathering of members and friends than before. It would, in fact, be difficult to overrate the technical ability and fertility of resource displayed by Mr. Gordon in the design and construction of these works, on which a sum of 300,000*l.* had been expended when his connection with the borough came to an end. Other contracts, for large sums, were then in hand, while the whole of the allied schemes, including flood works, sewerage reconstruction, and sewage disposal, were not only laid down in their main and subsidiary lines for successive completion, but a considerable portion of the two latter schemes had already been carried out. It may be mentioned that the sewage disposal works include steam pumping plant of 800 horse-power, the extent of land for the disposal of the sewage being 1375 acres—larger than any similar area in England, and coming next in this respect to the sewage farms of Paris and Berlin.

The works just named by no means exhaust the list of Mr. Gordon's labours in Leicester, where he performed, with exemplary patience and unremitting attention, the ordinary duties of Borough Surveyor, including the preparation of new building bye-laws, a

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borough boundaries extension scheme, and other general municipal work. All this tended to produce the inevitable result of overwork, and he was warned by more than one sudden, sharp, and exhausting attack of illness that his naturally slight frame could no longer withstand the demands which he had been accustomed to make upon it. This, however, did not deter him from becoming, early in 1889, a candidate for the Chief Engineership of the newly created London County Council, to which post he was elected in July of that year. Entering upon the duties of this important and honourable appointment on September 2nd, he devoted special attention to the permanent working of the newly completed sewage precipitation works at Barking and Crossness, besides commencing a comprehensive investigation of the condition and discharging capacity of the outfall sewers. In the midst of these congenial labours, and only ten weeks after taking office, he was instantaneously struck down by an attack of syncope, while in an omnibus on his way from his residence at Hampstead to his office in Spring Gardens.

Thus passed from our midst, on November 9th, 1889, and at the early age of 52, one whose loss has been keenly felt in the large and ever-expanding circle of his private and professional friends, to whom he had endeared himself as much by his genial and unassuming demeanour as by those sterling abilities which had done so much to make his reputation as an engineer of the very front rank in municipal and sanitary work. His name will always be associated with the realisation of a high ideal in every department of work with which he had to do, while there can be but one feeling of admiration for the determination and self-denial which so largely contributed to the undoubted eminence to which he attained in a profession whose best interests he ever had at heart. He took a leading part in the establishment, in 1885, of the examinations now regularly held by this Association, and acted as one of the examiners at Manchester, 1887, and London, 1888. Not only in this way, but in his generous assistance and counsel to individuals, Mr. Gordon manifested throughout his career a zealous interest in the welfare and advancement of the younger generation of engineers, many of whom gratefully acknowledge the value of the freely imparted advice which his almost unique experience so well qualified him to give.

The President and several members of the Council of the Association paid a last tribute of affection and esteem to the

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memory of their lamented colleague at the funeral which took place in Leicester Cemetery on November 13th, 1889, when a large and sympathetic gathering testified to the regard in which the deceased gentleman had been held in a town which owes so much to his labours.

Mr. EDWARD FRY was born at Nailsea, near Bristol, on the 6th of March, 1839. He began life by working at his father's business, that of a stone and marble mason. When a young man he came to London and obtained an appointment with the Islington Vestry, in whose service he remained until the 16th of July, 1874, when he was appointed, out of nineteen candidates, the Surveyor and Inspector of Nuisances to the South Hornsey Local Board, in succession to Mr. George Paice. At that time the Board, under the able chairmanship of the late George Chitty Boor, Esq., C.C., held their meetings at a small and inconvenient house in Spencer Road, and in 1879 it was resolved to erect office buildings to meet the requirements of the district, and further, that Mr. Fry should have the carrying out of the work. The able manner in which he fulfilled his trust is too well known to need description, and eminently meeting one of the highest qualifications of architecture, though sometimes overlooked, adaptability for the purpose required. The foundation of the new building was laid by the then chairman in September 1881, and the hall was reported as completed in May 1882. It was about this time that Mr. Fry married Miss Amelia White, daughter of the late Christopher White, Esq., solicitor, living at Brownswood Park. The designing and carrying out of the work was one of great labour, and was considered too much for one man to undertake, and especially one which might be termed extra official, but it was at Mr. Fry's expressed wish that he should be left alone in the work.

It was about this time the antecedents of his long illness were manifested in his naturally delicate constitution. An attack of pleurisy prostrated him for several months, and ever since then he suffered from what might be termed a waxing and waning of chest weakness, which terminated fatally on the 16th December, 1889.

In addition to the office buildings, Mr. Fry carried out a great amount of road construction in the district, chiefly in the almost entirely newly-formed district now known as the Brownswood Park division, which work is noted for substantiality and durability.

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Mr. Fry was elected a Member of the Association of Municipal Engineers on the 20th December, 1884.

The other deaths are James Farrar, of Bury, formerly Borough Surveyor of that town. Mr. Farrar was one of the earliest members of this Association. He was for some years in private practice in Bury, and died on the 18th April, 1889.

Mr. W. H. Wilds, of Hertford, died on the 17th April, 1890. He was elected Member on the 9th October, 1884.

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